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14. ABSTRACT This TOP provides basic information to facilitate planning, conducting, and reporting and to standardize chemical and biological (CB) contamination survivability testing of external surfaces of military materiel such as combat vehicles, vans, shelters, and large items of packaged materiel. It is designed to provide results to determine if large items of mission-essential (ME) equipment have met applicable CB contamination survivability requirements. This TOP describes typical facilities, equipment, and procedures used to contaminate equipment, sample for contamination density, decontaminate, sample for residual contamination, determine degradation of ME functions resulting from the contamination/decontamination procedures, and analyze crew/SUT compatibility.						
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US ARMY DEVELOPMENTAL TEST COMMAND  
TEST OPERATIONS PROCEDURE

\*Test Operations Procedure (TOP) 08-2-510A

21 March 2011

DTIC AD No:

CHEMICAL AND BIOLOGICAL CONTAMINATION SURVIVABILITY (CBCS),  
LARGE ITEM EXTERIORS

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1. SCOPE.

1.1 Background.

a. The classified Government Accountability Office (GAO) Report, Chemical and Biological Defense: Sustained Leadership Attention Needed to Resolve Operational and System Survivability Concerns, 30 May 2003 (GAO-03-325C<sup>1</sup>), identified several issues related to the ability of key defense systems to survive after being contaminated by nuclear, biological, and chemical (NBC) agents and after being decontaminated. In response to that report, a chemical and biological (CB) contamination survivability (CBCS) implementation plan was developed that was responsive to GAO concerns about the survivability of defense-critical systems and the need for increased management oversight to ensure system survivability. Subsequently, several key elements of that program plan were codified in the Fiscal Year 2005 National Defense Authorization Act (NDAA), Section 1053, Survivability of Critical Systems Exposed to Chemical or Biological Contamination [Public Law (PL) 108-375]<sup>2</sup>.

b. Consistent with the Public Law, on 31 August 2005, the Under Secretary of Defense (Acquisition, Technology, and Logistics) [USD (AT&L)] issued an interim Department of Defense (DoD) policy on CBCS<sup>3</sup>.

c. On 9 May 2005, USD (AT&L) issued a memorandum that established final DoD CBCS policy<sup>4</sup>. The final policy replaced the interim policy and included a process for identifying defense-critical systems that needed to be survivable, instructions on how CBCS should be addressed by the Military Departments, a process for DoD oversight, and definitions of decontamination, hardness, and compatibility.

d. Following the issuing of the DoD CBCS policy, details of how the CBCS policy is to be implemented were written into the DoD Instruction (DoDI) 3150.09<sup>5</sup>. The DoDI includes specific responsibilities of all the organizations impacted by the policy and also expands the CBCS requirement to include radiological and nuclear contamination survivability (CS), resulting in a chemical, biological, radiological, and nuclear (CBRN) CS document. In addition, a chemical and biological materials effects (CBME) database<sup>6</sup> was developed to address another requirement of PL 108-375.

1.2 Purpose.

a. The purpose of this test operations procedure (TOP) is to address CBCS of large item exteriors. Examples of large items are combat vehicles, vans, shelters, and large items of packaged materiel that are to be decontaminated.

b. The hierarchy or logic for testing/selection of tests (most desirable because of the information gained to least desirable) is:

\*Superscript numbers correspond to Appendix F, References.

(1) Full system agent or simulant testing (full information on the ability of a system under test (SUT) to meet the criteria). The use of the actual SUT is the most reliable and realistic method for assessing all aspects of the item's survivability. These aspects include assessing for agent trapped in cracks, crevices, between components, in angles, and in odd shapes not easily decontaminable, and evaluating the item's textures and geometry. If it is not feasible and/or cost effective to use the actual item to determine survivability, then based on coordination between the tester, the customer, and the evaluator testing alternatives will be considered and a choice for testing made.

(2) Scaled-down testing. A smaller version (e.g., one-quarter scale, etc.) will be used in place of the full-size version of the SUT. The test methods described in this document will still be used.

(3) Component agent testing. Information on the ability of a component or components to meet the criteria; the data can be extrapolated to the full system with appropriate planning. If the component method is selected for testing to represent a large item, the procedures in TOP 08-2-111<sup>7</sup> will be followed.

(4) Coupon panel agent testing. Information on the ability of a set of materials to meet the criteria is very difficult to extrapolate to the full system. If coupon or panel testing is selected, the panels must be made from the same materials as the large item being evaluated. The procedures in TOP 08-2-061<sup>8</sup> must be followed.

(5) Mock-ups. The mock-ups may be specially fabricated to simulate the SUT or may be the actual SUT with expensive optical, electronic, or other internal components removed. Mock-ups must be fabricated of the same materials, have the same coatings, and have similar design features as the intended developmental SUT. The mock-ups must be furnished and/or approved by the materiel developer. The similarities and differences between the mock-up and the SUT it simulates will be carefully analyzed and documented.

(6) Chemical, biological, and radiological (CBR) contamination survivability assessment (an assessment of the expected ability of the SUT to meet the criteria with the possibility of little or no agent data available for consideration). No actual testing conducted.

c. CBCS is the capability of a system and its operators to withstand a CB-contaminated environment, including decontamination, without losing the ability to accomplish the assigned mission. Characteristics of CBCS are decontaminability, hardness, and compatibility, defined in Paragraphs 1.4.a through c. Agent must be used to measure decontaminability and hardness for the full cycle (contamination, decontamination, and re-issue to warfighter). Simulants may be used to measure hardness against decontamination methods. CBCS should be monitored throughout the materiel acquisition cycle, evaluated, and assessed during developmental and operational testing.

d. This TOP provides basic information to facilitate planning, conducting, reporting, and standardizing CB survivability testing of military materiel. It is designed to provide results to demonstrate that large items of mission-essential (ME) equipment have met the policies of Army

Regulation (AR) 70-75<sup>9</sup> as implemented by the Department of the Army (DA) Approved NBC Contamination Survivability (NBCCS) Criteria for Army Materiel<sup>10</sup> and outlined in the Quadripartite Standardization Agreement (QSTAG) 747, Edition 1<sup>11</sup>. DoDI 3150.09 outlines chemical, biological, radiological, and nuclear contamination survivability (CBRNCS) requirements for mission-critical systems. To survive CB contamination, materiel must meet criteria for decontaminability, hardness, and compatibility. This TOP describes typical facilities, equipment, and procedures used during testing to contaminate equipment, sample for contamination density, decontaminate, sample for residual contamination, determine degradation of ME functions resulting from the contamination/decontamination (C/D) procedures, and analyze crew/SUT compatibility. Neutron-induced gamma activity (NIGA) and nuclear initial blast effects are not addressed in this TOP. Information on NIGA and initial blast effects can be obtained from other sources [e.g., Field Manual (FM) 3-11.3<sup>12</sup> and Allied Tactical Publication (ATP) 45C<sup>13</sup>].

e. The acronyms CB and the CBR are used in this document, rather than NBC, to reflect current terminology in use within the DoD. North Atlantic Treaty Organization (NATO) documentation still uses the term NBC, and this will be reflected in the references within this document.

### 1.3 Limitations.

a. This TOP does not cover testing of small items of equipment, which is described in TOP 08-2-111. Also, this TOP does not cover testing of the interior spaces of large items of equipment.

b. When testing is conducted using simulants for chemical warfare agents (CWAs) or agents of biological origin (ABOs) without a corresponding agent/simulant correlation or relationship, the test data should not be used without the establishment of the agent/stimulant relationship.

c. This TOP does not cover the testing for radiological contamination survivability. The methodology to conduct this testing is under review because current methods cannot be related to measuring residual radioactivity. Radiological contamination survivability testing of equipment and systems, as specified in the CBR contamination survivability (CBRCS) criteria (reference 10), includes NIGA and activity resulting from fallout of radioactive dust and debris. The induced activity creates physical changes to materiel properties of the SUT, which remain even after removal of the radioactive dust and debris. The contributions from both sources must be considered when determining the radiological contamination survivability of an item. Unfortunately, removal or reduction of induced radiation is not possible by current CBR field-decontamination materials and procedures, and induced activity hazard testing requires different facilities, instruments, and safety considerations from those described in this TOP. Survivability from immediate nuclear blast effects and NIGA are not covered in this TOP.

d. The only criteria for CBRCS as listed in this TOP are for the Department of the Army (reference 10). Although there is an AR and a DoDI covering CBRCS policy there are no additional criteria. For acquisition programs that have CBRCS requirements the default is to use

the DA criteria. These criteria are not for use in determining decontamination efficacy, but only CBRCS.

e. There are many factors that can affect the performance and/or survivability of a system before and after the conduct of decontamination operations. Many of these factors cannot be evaluated for their effects. An example would be the age of the paint on the surface (aged, new, etc.).

f. The only current mechanism for converting agent mass from solid sorbent tubes (SSTs) or bubblers or concentrations collected by MINICAMS<sup>®</sup> (a miniature, automatic, continuous air-monitoring system) is to use a downwind hazard prediction model<sup>14</sup>. Once a decontamination system performance model is developed with the necessary toolset, then that model may replace the current model.

#### 1.4 General Criteria Evaluations.

The following procedures must be used to quantitatively evaluate the ability of an item tested to meet the criteria for decontaminability, hardness, and compatibility.

##### 1.4.1 Decontaminability.

###### a. Chemical.

(1) Vapor Hazard. The effective concentration of agent vapor desorbed over time is  $C_e$ . The mission time provided by the user is  $t$ . Then  $C_e t = \text{dosage}$ , which should be compared with the appropriate criteria (reference 10). The collection of data used in the determination of vapor hazard is critical.

(a) When vapor sampling small SUTs, coupons, and even components, the entire SUT can be placed in a vapor off-gas box and residual vapors sampled. As the SUTs become larger, the ability to collect vapors from the entire SUT becomes extremely complicated. Thus the development of a sampling technique described in Paragraphs 4.1.5.13.a.(1) through (2). The sampling technique allows for the collection of multiple vapor samples (representing 1 square meter areas) and the extrapolation of the analytical data to the exposed surface area of the SUT.

(b) Traditional vapor samplers (bubblers and SSTs) sample vapor streams for discrete periods of time defined by a sampling plan. The bubbler solvent containing agent or the SSTs with agent residing on the sorbent are analyzed and the mass of residual agent quantified. The volume of agent containing air is determined by using critical orifices to restrict the airflow through the sampler and flow rating the critical orifice on the upwind side before and after the sampling period. The two flow rates allow a determination of whether or not the airflow through the sampler changed over time. The mass of agent is used to calculate the average concentration during the sampling period by multiplying the mass times the volume of air that passes through the sampler. The dosage is calculated by multiplying the concentration by the time of sampling and then accumulating the dosage for all sample periods for a total dose.

(c) The MINICAMS<sup>®</sup> is used to replace the traditional vapor samplers as a near real-time analytical method. The MINICAMS reports concentrations. The air sampling rate is controlled by a mass flow controller at 0.5 m/s. The sampling times (sample then analysis and purge) range from 3-15 minutes. The concentration can be multiplied by the total sample time for a total dose.

(d) The size of the enclosure or vapor off-gas box used on SUTs can significantly affect the residual vapor data collected and must be given serious consideration when designing the test. If a small SUT is placed in a large off-gas box, then the residual agent vapor can be diluted in the large volume of air in the box resulting in an underestimation in the calculation of the concentration and total dose. Likewise, if a small SUT is placed in an off-gas box only slightly larger than the SUT, then the residual agent vapor has a large presence in the smaller volume of air resulting in an overestimation in the calculation of the concentration and total dose.

(e) In order to deal with the issue of the volume of the off-gas box new methodology has been developed that normalizes the volume of the off-gas box used. Instead of reporting only a concentration or total dose, the toxic load of the airflow is calculated and used to characterize the SUT emission rate. The emission rate can then be used to develop multiple scenarios with the SUT and determine if any of the scenarios represent a vapor hazard. This new methodology can be found in the Baseline Source Document Chemical Decontaminant Performance Evaluation Testing<sup>15</sup>.

(2) Contact Hazard. The mass collected by the contact samplers should be adjusted for the average area of human contact with the item. This value should be compared with the appropriate mass value in Table 1 of the criteria for Army materiel (reference 10).

#### 1.4.2 Biological.

The colony forming units (CFUs) (spores that have become viable cells) that are sampled after decontamination are divided by the number of CFUs sampled after contamination of the SUT. This ratio then is expressed as the log reduction and is compared with the appropriate criterion (reference 10). The criterion is based on a spore count, and because it is impossible to realistically count individual spores, a CFU reduction of 6 logs (i.e., reduced by a factor of one million) is used instead. If the SUT CFU reduction is  $\geq 6$  logs, then the SUT has successfully met the criterion for biological decontaminability.

#### 1.4.3 Hardness.

Hardness can be determined by measuring physical properties of coupons or by measuring identified ME functions (e.g., number of rounds fired, ability to send radio messages, the computer boots up and software functions appropriately, etc.). If, after the C/D process, the SUT has suffered a reduced capability in the ME functions, then the percent reduction can be compared with the criterion (reference 10). When material-effects coupon testing is conducted, it is difficult to determine if a reduction in ME functions has occurred. The system developer needs to evaluate the changes in physical properties to determine if the change meets or fails to meet the ME performance criterion (reference 10).

#### 1.4.4 Compatibility.

The ability to obtain operationally relevant data during developmental or laboratory testing is extremely limited and may have to be obtained during operational testing. Functions relating to the operation of the system tested are measured while individuals and/or crew members are wearing normal uniforms and while wearing mission-oriented protective posture, level IV (MOPP IV). The percent difference in times is calculated, and if it is less than 15 percent (reference 10), then the SUT has successfully met the criterion for compatibility.

## 2. FACILITIES AND INSTRUMENTATION.

Facilities, instrumentation, and safety procedures used for CB survivability testing are strictly controlled. Additional discussion and requirements for facilities and instrumentation are included in the test procedures (Paragraphs 4.1 through 4.4).

### 2.1 Facilities.

<u>Item</u>	<u>Requirement</u>
Chemical surety laboratory and chemical agent storage facility.	Constructed to ensure safe and secure storage, handling, analysis, and decontamination of chemical agents and/or simulants used for surety materiel.
Chemical agent test facility (chamber).	Constructed to house the SUT during agent or simulant C/D and sampling. The chamber should have sufficient volume to allow free air circulation around the SUT. Ability to control temperature, relative humidity (RH), and wind speed is required.
Fielded decontaminating apparatus as specified in the concept of operations (CONOPS).	Constructed to decontaminate the SUT as part of the test procedure.
Standard decontaminating apparatus.	Constructed to decontaminate the surety test facilities after test completion.
Chambers for biological simulant testing.	The chamber should be equipped with an air intake and an exhaust system, and should have sufficient volume to allow free air circulation around the SUT. Biological surety regulations will be followed if biological surety material is used at any time. Ability to set and maintain temperature and RH is highly desirable.

<u>Item</u>	<u>Requirement</u>
Test range or appropriate operational test facility.	Required to allow the SUT to be operated and to perform all ME functions and tasks required to accomplish specific CONOPS as outlined in the capabilities documents. This includes tasks such as communications, aiming and tracking targets, firing weapons, using optical instruments, operating controls and switches, reading instruments, resupply, and decontamination. Observation and measurement of any degradation of the ME functions attributable to the C/D procedures or CB protective equipment that the SUT operators are required to wear must be recorded.

## 2.2 Instrumentation.

Permissible error measurement values are minimum requirements. Actual instrumentation (Appendix A) may have greater accuracy, and actual values should be reported.

<u>Parameter</u>	<u>Measuring Device</u>	<u>Permissible Error of Measurement</u>
Air temperature.	Thermocouple or other.	-20 to 120 $\pm$ 0.5 °C.
RH.	Hygrometer or other.	0 to 90 $\pm$ 3 percent.
Wind speed.	Anemometer or other.	0 to 5 $\pm$ 0.1 m/s.
Photographs.	Still color camera.	Adequate to document typical test procedures, details of contamination techniques and contamination density [including mass median diameter (MMD) of drops], and any discrepancies from planned procedures necessitated by operational conditions.
Video.	Video camera.	Adequate to document typical test procedures, details of contamination techniques and contamination density (including MMD of drops), and any discrepancies from planned procedures necessitated by operational conditions.

### 2.2.1 Chemical Test Instrumentation.

Permissible error measurement values are minimum requirements. Actual instrumentation may have greater accuracy, and actual values should be reported.

<u>Parameter</u>	<u>Measuring Device</u>	<u>Permissible Error of Measurement</u>
Chemical agent vapor.	Bubblers, MINICAMS <sup>®</sup> , solid sorbent tubes (SSTs), or equivalent.	± 5 percent L/min (flow rate). The expected range is from 0.5 to 1.2 L/min. The minimum quantification level for distilled mustard (HD) is 50 µg, for soman (GD) is 2.5 µg, and for persistent nerve agent (VX) is 250 ng.
Chemical agent mass from vapor samples (µg).	Gas chromatograph (GC), high-performance liquid chromatography (HPLC), liquid chromatography (LC), spectrophotometer, or equivalent.	± 15 percent of calibration standard.
Contamination density or challenge level (g/m <sup>2</sup> ) and drop size (mm). Chemical agent mass from liquid samples (µg).	GC, HPLC, LC, spectrophotometer, or equivalent.	± 15 percent of calibration standard.

### 2.2.2 Biological Test Instrumentation.

Permissible error measurement values are minimum requirements. Actual instrumentation may have greater precision, and actual values should be reported.

<u>Parameter</u>	<u>Measuring Device</u>	<u>Permissible Error of Measurement</u>
Background contamination.	Microscopes, swabs or wipes placed in growth medium, automatic colony counters, or equivalent.	± 10 percent CFU/sample
Post-contamination verification.	Microscopes, swabs or wipes placed in growth medium, automatic colony counters, or equivalent.	± 10 percent CFU/sample.

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<u>Parameter</u>	<u>Measuring Device</u>	<u>Permissible Error of Measurement</u>
Post-decontamination.	Microscopes, swabs or wipes placed in growth medium, automatic colony counters, or equivalent.	$\pm 10$ percent CFU/sample.

### 2.2.3 CB Hardness Test Instrumentation.

<u>Parameter</u>	<u>Measuring Device</u>	<u>Permissible Error of Measurement</u>
ME functions as described in specific CONOPS	As necessary (optical haze, transmittance, durometer, tensile strength, etc.).	Precision and accuracy requirements must be compatible with the nature of the SUT and type of function but must allow for the detection of 20 percent degradation in the ME performance characteristic after completion of each of the required C/D cycles.

### 2.2.4 CB Compatibility Test Instrumentation.

<u>Parameter</u>	<u>Measuring Device</u>	<u>Permissible Error of Measurement</u>
Operator performance tests.	Stop watches or equivalent. Operator/crew ME functions (e.g., setting up a shelter, conducting maintenance operations, etc.) are timed functions. The standards for ME functions are outlined in system-specific doctrinal and training publications or are established by the combat developer for that system. The difference between the function performed with duty uniform and with MOPP IV allows a determination of the percent degradation.	Precision and accuracy requirements must be compatible with the nature of the SUT and type of function being studied, but must allow for the detection of 15 percent degradation (reference 10) in the item/operator ME function performance in five trials or less.

### 3. REQUIRED TEST CONDITIONS.

a. CBCS testing requires the handling and use of chemical and biological agents. Such testing is strictly controlled by US Army Regulations (e.g., AR 385-10<sup>16</sup>, DA Pamphlet ((PAM)) 385-61<sup>17</sup>, and DA PAM 385-69<sup>18</sup>). Throughout testing, primary emphasis must be on operator and test safety, but the importance of technical quality, completeness of test data, and conformance with specified test and operating procedures cannot be overemphasized.

b. The required test parameters (reference 10) are temperature  $30\pm 2.0$  °C and airflow across the SUT less than 1.0 m/s. There is no requirement for relative humidity.

#### 3.1 Test Planning.

a. Each CBCS test plan must be reviewed for technical accuracy and conformance to regulations and standing operating procedures (SOPs) applicable to the specific item and tests being conducted. In addition, the test plan must accurately reflect the requirements outlined in capabilities documents. Published test records, procedures, and the case files of similar SUTs must be reviewed to identify potential areas that are difficult to decontaminate. All SOPs and procedures must be reviewed for current, adequate, and complete information.

b. The capabilities documents (initial capability document (ICD), capability development document (CDD), or the capability production document (CPD)), the CONOPS, and failure definition/scoring criteria (FD/SC) must be reviewed. The operational test agency (OTA) evaluation plan (OEP) and the test and evaluation master plan (TEMP) will be used to determine the overall test structure, data required, criteria, and analysis to be used. The ME function, performance characteristics, and the ME Warfighter tasks specified by the materiel developer and the combat developer, respectively, will be listed. These will be used to measure degradation in performance caused by CB C/D and by the need for the operator to wear the CB protective ensemble. Units of measurement and the accuracy and precision required for each parameter measured will be identified. All issues concerning measurable performance and degradation will be reviewed.

c. Based on the information collected from the capabilities documents, the OEP, and the TEMP, and in coordination with the customer, the number of SUTs and the number of C/D cycles that need to be conducted on the SUT will be determined. The NATO QSTAG<sup>11</sup> dictates that a default of five C/D cycles should be conducted on each SUT to accommodate a radiological cycle, a biological cycle, and three chemical agent cycles for the three classes of CWA outlined in the QSTAG. Because there are no radiological procedures in this TOP, more biological or chemical cycles may be added. It is possible that less than or more than five cycles may be required.

d. A realistic sample size (based on test cost, as well as SUT size, value, and availability) will be determined through review and coordination with the assigned operational test activity evaluator. The sample size may be determined by SUT availability, cost, or other factors which may cause it to be less than optimum. If sample size is less than optimum, a testing scheme will

be devised to optimize SUT use and required data output. The use of the design of experiment will be considered in developing the test matrix.

e. Representative areas of the SUT to be sampled for residual contamination will be selected and identified. If the entire SUT cannot be contaminated and decontaminated, then representative areas for contamination, decontamination, and sampling will be selected. Selection of the sample locations will depend on consideration of overall SUT size, geometry of the SUT, materials of construction, surface texture, presence of joints and crevices, areas handled/touched by system operators, and the likelihood to contribute to crew vapor and contact hazard. Because of the nature of sampling devices, sample locations need to be flat or nearly flat. Coupons of the same material (including any paint, anodizing, etc.) can also be used by attaching the coupons on the sample location and removing them for liquid extraction of residual contaminant. An appropriate number of such areas will be selected to help ensure the statistical validity of the resulting sample size. The test plan will identify and explain the rationale for the areas selected and the statistical analysis methodology used. The test report will identify any changes from the test plan. Each sample location selected should be described and photographed. No additional marks should be placed within the marked boundaries of the locations to be sampled.

f. C/D cycles will be conducted using CB agents and/or simulants, and fielded decontamination systems and procedures. Actual survivability can only be confirmed by using actual agents. The default chemical agents are VX, HD, and thickened soman (TGD). Decontamination systems and decontaminants include, but are not limited to: the M291 skin decontamination kit; the M295 individual equipment decontamination kit; the M100 sorbent decontamination system; the M12; the M17; hot soapy water (HSW); and super tropical bleach (STB). Field expedient decontaminants include but are not limited to: high-test hypochlorite (HTH, a STB substitute); household bleach solutions (usually a ratio of one part bleach to ten parts water); alcohol-wetted cloth (for sensitive equipment); and low-pressure, high-volume water. A brief summary of these decontamination system procedures is found in Appendix B.

g. If the SUT consists of materials similar to other systems already tested [both systems chassis are chemical agent resistant coating (CARC) painted steel or both systems are bulldozers with one being larger than the other], then consideration may be given to conducting a CB materiel survivability assessment as a cost-saving measure. Before implementing this option, coordination must occur with the test sponsor and the OTA conducting the system evaluation. The SUT design and the materials of construction will be examined. The materials of construction will be reviewed to see if any data can be found in the CBME database, and an analysis will be performed based on previous test experience and technical information concerning the material's ability to survive exposure to contamination, decontaminants, and the decontamination process. If there are material effects data in the CBME, then it can be reviewed for applicability to the current SUT. Any areas where agent could pool or seep, such as cracks, crevices, hinges, joints, countersunk screw heads, or other difficult to decontaminate features, will be noted. It is recommended that any identifiable vulnerabilities or questionable design or materials are adequately tested. If the previous steps reveal any aspect of design or identify a material that appears to make test failure probable, testing of the suspect design or material should be performed early in the test cycle. Preliminary results can often be determined from a

pilot study and analysis of the collected information. The report of the survivability assessment will detail the expected ability of the SUT to meet the CBCS criteria (reference 10).

h. For tests involving the use of simulants, qualified and trained operators and standard equipment (decontamination, maintenance, and calibration, etc. that Warfighters would use with the system) will be scheduled. Standard decontamination procedures will be developed for the SUT, if required. Before testing begins, rehearsals must be held to familiarize the test team with the functioning of the SUT, test procedures, and data requirements. The team must practice using simulants until agent-dispensing, decontamination, and sampling become reproducible and routine. The SUTs used during the actual test should not be used for rehearsals with simulants, unless it is the only SUT available and testing will be conducted outdoors. It is recommended that one or more dry-runs be performed to give operators an opportunity to demonstrate, standardize, and confirm operational procedures.

i. For tests involving threat agents, the appropriate laboratory will be scheduled to conduct the test, and laboratory technicians will receive appropriate system operating training before testing begins.

### 3.2 Environmental Documentation (U.S. only).

All local, state, and federal regulations will be complied with, appropriate documentation prepared and submitted, and approval received before testing begins.

### 3.3 Safety.

Applicable safety and surety regulations will be reviewed to ensure compliance of all test procedures.

### 3.4 Quality Assurance (QA).

a. Controls and limitations applicable to specific subtests are presented in Paragraph 4 as part of the procedure to which they apply.

b. A QA plan should be prepared for each test program to ensure that all variables that can be controlled are controlled and that appropriate records are kept throughout the duration of testing. Variables that cannot be controlled must be identified in the test plan. Test variables include, but are not limited to: purity and stability of agents and simulants used, purity and stability of decontaminants, calibration and maintenance of instrumentation and disseminators, accuracy and precision of the laboratory analysis, and quality and uniformity of all test samples.

c. The condition of the SUT at the time of testing is an important test variable. Unless receipt inspection was part of a subtest completed before CBCS testing, the SUT should be inspected in accordance with (IAW) TOP 08-2-500<sup>19</sup>. Inspection data, certificates of compliance, or similar documentation, should be reviewed to ensure that exterior surfaces, finishes, and packaging meet specifications. Generally, the item should be tested in as-received condition, matching its condition when issued to Warfighters in the theater of operations as

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closely as possible. CBCS testing may be required periodically throughout the equipment life cycle if the effect of normal wear is a major factor in survivability.

d. Decontamination. Existing system-specific decontamination procedures, using fielded decontaminants or developmental decontaminants, should be reviewed and incorporated into the planned test as much as possible. Any deviations from existing procedures in the test plan must be documented in the test report.

e. Test Conduct. Testing must always be conducted IAW approved test documentation, such as technical manuals, FMs, equipment operating instructions, SOPs, this TOP, the approved test planning directive, OEP, TEMP, and the test plan. Deviations from test documentation will be put in writing and approved by the appropriate authority as part of the test plan and report preparation.

#### 4. TEST PROCEDURES.

Paragraphs 4.1 and 4.2 address chemical survivability testing, and biological survivability testing separately. Although the test methods are similar, subtle but important differences exist. Long-term CB hardness and CB compatibility are discussed in Paragraphs 4.3 and 4.4.

##### 4.1 Chemical Contamination Survivability.

###### 4.1.1 Objectives.

a. Decontaminability. The ability of a system to be rapidly and effectively decontaminated (less than 75 minutes) (reference 10) following chemical agent exposure will be determined. Vapor and percutaneous hazards, including eye effects, associated with the Warfighter's use of equipment that has been contaminated with chemical agent and decontaminated using standard and/or item-specific decontamination procedures will be measured.

b. Hardness. The capability of a system to withstand the material damaging effects of chemical agent and relevant decontaminations will be determined. The degree of performance degradation in ME functions of military ME materiel after chemical agent C/D by standard and/or item-specific procedures will be measured.

c. The process for identifying mission-critical equipment is outlined by the policy found in DoDI 3150.09. ME functions are those functions that define the successful completion of a mission for the SUT as defined by the test sponsor and/or combat developer in the FD/SC.

###### 4.1.2 Criteria and Conditions.

###### 4.1.2.1 Criteria.

a. Decontaminability. The exterior surfaces of materiel developed to perform ME functions shall be designed so that chemical contamination remaining on, or desorbed from, the

surface following decontamination shall not result in more than a negligible risk (5 percent mild incapacitation) to unprotected individuals working inside, on, or 1 m from the item/equipment after chemical agent C/D as stated in the criteria (reference 10).

b. Hardness. Mission-critical equipment shall be hardened to ensure that exposure to the specified C/D cycles does not degrade the operational ME performance of the equipment more than 20 percent (or that specified by the combat developer) over a 30-day period (reference 10) or as defined by the capabilities documents.

c. As an example, if a howitzer is consistently able to fire 25 rounds per 30 minutes before decontamination and can only fire 20 rounds per 30 minutes after five cycles of decontamination, then the degradation is measured as  $(25-20)/25 \times 100 = 20$  percent. Another example would be the faceplate of the protective mask that had a transmittance of 99 percent and after five cycles of decontamination the transmittance is measured as 97 percent. The degradation is calculated as  $(99-97)/99 \times 100 = 2$  percent.

#### 4.1.2.2 Conditions.

General conditions are as follows:

a. Selected exterior areas will be initially contaminated in a random drop pattern over the selected area, to a contamination density as specified in the system threat assessment and capability documents (default of 10 g/m<sup>2</sup>) with 5- to 10-microliter (μL) drops of TGD and 2- to 5 μL drops of HD, or VX. The CWAs, VX, HD, and TGD are required for testing by the DA Approved NBCCS Criteria for Army Materiel (reference 10). The selection of areas to be contaminated is based upon the concept that there will be a “rain” of airborne contaminant onto items. The “rain” is usually defined as coming from a 30-degree angle from vertical. Therefore, there is an expectation that only the top, one side, and one end of the SUT will become contaminated. Because of the potential for large areas to be contaminated and the difficulty in working with a large item, areas are also selected for contamination that are identified as representative of areas that would be handled or touched by the system operators, or that would impact operation of the SUT (e.g., hatch handles, vision blocks, climbing rungs, etc.).

b. The purity of the chemical agents used must be known and recorded as test data. Ensure that a purity certification is provided with the agent used for testing and that the certificate has been issued within the last 12 months. The quantity applied may be adjusted to achieve the required pure agent contamination density. If weapons-grade agent is used, the purity must be measured and recorded as test data. If simulant testing is necessary, a simulant/agent correlation must be fully documented IAW the provisions of Paragraph 4.1.7.

c. The amount of time between contamination and the start of decontamination operations (often called weather time) will depend on requirements in capability documents. The default weather time is 60 minutes (reference 10). Given changes in battlefield doctrine, the default weather time may not be representative of the actual travel time from a contamination site to a decontamination site. Weather time should be coordinated with the test sponsors and combat developers. Standard field and/or item-specific decontaminants, equipment, and

procedures will be used as much as possible. The decontamination procedure conducted and the time between C/D cycles will be included in the test plan for each SUT. The decontamination process time (excluding point detector monitoring) should be recorded.

d. The chamber and item surface temperature will be 30°C and chamber wind speed no greater than 1 m/sec (reference 10).

#### 4.1.3 Controls and Limitations.

The controls and limitations for chemical agent/simulant contamination survivability testing are:

a. Surface of the SUT.

(1) Surface areas selected for sampling must be representative of the surface materials, texture, paint, and areas where the user will have direct contact.

(2) Before each trial, the surfaces of the SUT must be inspected and sampled (vapor and contact) for background contamination. Any foreign substances on the SUT that could interfere with sampling the surface or interfere with analytical instrumentation must be removed (e.g., with inert solvent, HSW, etc.) before testing.

b. Analysis control data include standard analytical controls (see Paragraph 4.1.5.6). The standards need not be at equal concentration intervals; rather, they should be spaced closer together near the low-concentration end of the calibration curve IAW SOP DP-0000-M-073<sup>20</sup>.

c. Test controls should include:

(1) Vapor only. Non-operated sampler control (a sampler taken into the area surrounding the SUT but not used, opened, or aspirated).

(2) Vapor only. Operated sampler control (a sampler taken into the area surrounding the SUT and used, opened, or aspirated, but not exposed to agent or simulant).

(3) Positive control, which is a SUT or coupon contaminated but not decontaminated.

(4) Negative control, which is a SUT or coupon that is not contaminated, but is decontaminated.

d. Instrumentation calibration will be recorded as part of the test record and will include the calibration requirement (yearly, semiannual, etc.).

e. Data Analysis. Data analysis for the actual item and component testing are the same. The resulting data for component testing may or may not be applicable to the whole SUT.

f. Threat agent tests will be conducted inside a surety test facility (chamber) approved for use with chemical agents.

4.1.4 Data Required. The following data in the units indicated will be reported.

- a. Test Chamber/Hood.
  - (1) Temperature in °C.
  - (2) RH in percent.
  - (3) Wind speed (airflow) in m/sec.
- b. Agent or simulant.
  - (1) Name and control number.
  - (2) Purity in percent.
  - (3) Name, product identity, and manufacturer of thickener (if thickened).
  - (4) Viscosity after adding thickener (if thickened) in centistokes (cSt).
  - (5) Time since thickening, if thickened.
  - (6) Name, product identity, and manufacturer of dye (if used).
  - (7) Quantity of dye and/or thickener (if thickened) in g/L.
  - (8) Quantity of agent/simulant dispensed in g.
  - (9) Agent/simulant contamination density in g/m<sup>2</sup>.
  - (10) Agent/simulant drop diameter in mm (drop size distribution and mean).
- c. Results of each post-decontamination agent/simulant vapor and contact sample (collected during the sampling period) in µg/sample.
- d. Complete description of the contact sampler used (material type, lot number, diameter, thickness, and any other pertinent information). Description of any contact sampler efficacy and/or solvent extraction efficacy studies conducted on the contact sampler and solvent used for extraction.
- e. Total number and location of contact samplers.
- f. A description of the required contact-sampling times specified.
- g. Results of sampling and analysis controls and standards in µg/sample.

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- h. Sample history with elapsed time to analysis in days.
- i. Contamination, weathering, decontamination, and sampling elapsed times in minutes.
- j. Description of decontamination solutions (i.e., formulation, active ingredients, lot number, and age).
- k. Methods, equipment, and item-specific procedures used during decontamination.
- l. Description and photographs of SUT exterior surface condition (pretest), including construction materials, paint type, paint thickness (number of coats), paint condition, and surface cleanliness (mud, grease, etc.).
- m. Description and photographs of SUT joints, cracks, crevices, and other features that could allow contaminants or decontaminants to enter below the surface and may be difficult to decontaminate.
- n. Pretest (baseline) and posttest (30 days after the first contamination and/or other defined long-term time interval) ME functional performance data, recorded to the highest level of accuracy and precision that is commensurate with the parameter being measured.
- o. The stain size, on the surface if any, caused by the agent drops (if safety procedures permit, and if these data are desired).
- p. Description and photographs of any materials degradation (e.g., corrosion).
- q. Identification of the C/D cycle event.
- r. Posttest questionnaire results (outdoor testing only).
- s. Any relevant safety findings as a result of testing.

#### 4.1.5 Methods and Procedures.

##### 4.1.5.1 Test Method Outline.

- a. Receipt inspection will be conducted on the SUT to document as-tested material conditions. Receipt inspection may include functional performance tests to establish baseline performance parameters (e.g., computer is operational, aircraft avionics are operational, etc.). Paragraph 4.1.5.7 describes the details for this step of the test method.
- b. The agents/simulants will be prepared for application as described in Paragraph 4.1.5.8.
- c. SUT will be prepared for testing, to include sample location, identification and documentation; marking of sample areas; etc. Paragraph 4.1.5.9 describes the details of this step.

d. Test chamber operation will be verified and environmental conditions for the test stabilized (if test is conducted in a chamber). If an item is too large to fit properly in a chamber, testing may be conducted outdoors. Environmental conditions are monitored, the SUT is allowed to equilibrate with the ambient conditions, and any required background samples are taken before contamination IAW Paragraph 4.1.5.10.

e. Agents/simulants are applied to the item under test. Paragraph 4.1.5.11 describes the details of this step.

f. Decontamination operations will be conducted on the item under test as described in Paragraph 4.1.5.12.

g. Post-decontamination vapor and liquid (contact) sampling and sample analysis will be conducted as described in Paragraph 4.1.5.13.

h. Hardness determination, including post-decontamination functional performance measurements, will be performed IAW Paragraph 4.1.5.14.

i. Data analysis and hazard determination will be performed IAW Paragraph 4.1.6.

#### 4.1.5.2 Significance and Use.

a. The sample data collected from this test allow a determination of contact and vapor hazards to unprotected personnel from decontaminated military materiel.

b. The functional performance and/or material effects data collected allow a determination of the amount of physical or functional degradation of the SUT resulting from CB C/D procedures and materials to determine if there is a hardness issue.

c. Exact repeatability is lost with outdoor testing because of the variable natural environmental conditions.

#### 4.1.5.3 Interferences.

a. There are no interferences when the test method is conducted under laboratory-controlled conditions.

b. Outdoor testing has inherently uncontrolled or extreme variances in temperature or humidity. The extreme variances are constituents or properties that will create test conduct interferences.

#### 4.1.5.4 Apparatus.

a. The term apparatus will be used to cover the test fixture in which a test method may be conducted as well as the equipment used in conducting testing, sampling, and analytical instrumentation.

b. Special fixtures may be required because of the wide variety of systems that could be tested (e.g., a large frame cargo aircraft to a small missile). Each fixture will have to be manufactured to fit the size of the SUT and still remain in an agent capable chamber. Each fixture should be capable of maintaining an airflow around the SUT, allowing operators to easily reach the SUT for agent application, decontamination, and to perform contact or residual liquid sampling. If the SUT is too large for an agent capable chamber, then alternative testing solutions can be found in Paragraphs 1.2.b(1) through (6). Additional methodology may be required to perform vapor sampling (see Paragraph 4.1.5.13).

c. The instrumentation used in test method conduct, sampling for residual liquid and vapor, and the analytical equipment for sample analysis are found in Paragraphs 2.2 and 2.2.1.

#### 4.1.5.5 Hazards.

a. Identified safety hazards are those associated with testing using toxic chemical surety materials, simulants, and decontaminant chemicals that are hazardous in and of themselves (e.g., chlorine, hydrogen peroxide, etc.). Chemical safety guidelines are found in DA PAM 385-61.

b. Testing conducted on large items of equipment may also have slipping or falling hazards<sup>16</sup> when attempting to conduct decontamination operations on the equipment.

c. A test plan must be developed with a safety section identifying and addressing all safety concerns for each test conducted using these methods IAW AR 385-10. The safety section of the test plan will be coordinated with the test site's safety office.

#### 4.1.5.6 Calibration and Standardization.

a. General chemical analytical calibration guidelines are found in SOP WDC-ANA-004<sup>21</sup>. These guidelines can be used for most chemical analytical equipment (e.g., GCs, LCs, etc.). A sample sequence will be created that includes the following:

- (1) A solvent blank to evaluate method interferences.
- (2) Calibration standards (ranked low to high or high to low) with at least five standards. Preparations of standards are described in SOP DP-0000-M-073.
- (3) A solvent blank to evaluate carryover.
- (4) Quality control (QC) sample to validate the calibration curve, at least one sample per detector (if multiple detectors are installed on the same instrument) including control samples.
- (5) Another solvent blank.

b. The test samples will be placed in the sample sequence and analyzed by the calibrated equipment.

- c. Using the instrument software (where available), the calibration curve will be built from lowest to highest.
- d. Plot information will be evaluated as follows:
  - (1) Curve fit type (linear, quadratic, etc.) will be selected.
  - (2) Point weighting (equal, inverse, etc.) will be selected.
  - (3) If correlation value ( $R^2$ ) is greater than 0.995, then analysis will proceed.
  - (4) If correlation value is less than 0.995, then one data point can be removed and the calibration curve recalculated.
  - (5) If correlation still fails, each data point will be evaluated to determine any errors.
  - (6) Method adjustments will be made and the calibration repeated.
  - (7) If correlation fails, help within the organization will be requested.
- e. If all criteria are met, the QC sample will be loaded and processed against the calibration curve.
- f. The calculated values for the QC sample must be within  $\pm 15$  percent of the expected value.
- g. If the QC calculated value passes, then the test method will proceed.
- h. If the QC calculated value fails, then a second QC sample will be run.
- i. If the second QC calculated value passes, then the test method will proceed.
- j. If the second QC calculated value fails, then corrective actions will be taken and the instrument recalibrated.
- k. After any maintenance action to the instrument, two QC samples must pass the  $\pm 15$  percent criteria or corrective actions and recalibration must be performed.

#### 4.1.5.7 Receipt Inspection and Functional Performance.

- a. SUTs should be inspected for shipping damage, completeness of assembly, required accessories, and necessary manuals, logbooks, etc. Any missing components, damage, or other discrepancies noted will be documented.

b. Surfaces will be inspected for foreign materials normally not present on the item (dust, mud, grease, or marking). Foreign materials may be removed by brushing, vacuum cleaning, or washing with soapy water and sponge. The removal of foreign materials will minimize the bias that could create an over/under-estimate of the true contamination survivability of the SUT. The surface condition, surface cleanliness, corrosion, materials of construction, variance from standard painting, and paint condition will be recorded.

c. The SUT will be operated IAW the operator's manual. ME functional performance characteristics (e.g., electronic functions, shelter setup, etc.) identified by the combat developer (e.g., in the failure definition/scoring criteria) must be measured and recorded. Based on the selected functional performance characteristics, each functional performance characteristic should be designated as either a functional performance attribute (go or no-go) or as a functional performance variable measured over a continuous range of values. Each parameter must be measured at least twice and must be recorded to the smallest significant units of measure. If any damage, surface condition, or a ME functional performance characteristic falls outside developer specifications, then testing will not proceed.

#### 4.1.5.8 Agents/Simulants Preparation.

a. The agents to be used are as follows:

(1) Neat VX with a purity greater than 85 percent, unless weapons-grade is desired (SOP WDC-ANA-031<sup>22</sup>). The agent may be prepared with approximately 0.5 percent (weight/volume) of a suitable dye (SOP WDC-ANA-012<sup>23</sup>).

(2) Neat GD with a purity greater than 85 percent unless weapon-grade is desired (SOP WDC-ANA-031), and thickened with 5 percent (weight/volume) of Rohm and Haas Acryloid™ K125 (Philadelphia, Pennsylvania) poly(methyl methacrylate) (SOP WDC-ANA-012). This should provide thickened agent with a viscosity of 1,000 cSt at 20 °C. During preparation, batch-to-batch variability in viscosity may be greater than 10 percent. This large variability can be reduced by slowly adding the thickener over long periods of time. Complete solution of the polymer in GD is slow; therefore, mixing should continue until the measured viscosity is constant. The agent may be prepared with approximately 0.5 percent (weight/volume) of a suitable dye (SOP WDC-ANA-012).

(3) Neat HD with a purity greater than 85 percent (unless weapons-grade is desired) (SOP WDC-ANA-031). The agent may be prepared with approximately 0.5 percent (weight/volume) of a suitable dye (SOP WDC-ANA-012).

(4) Other approved contaminants [e.g., non-traditional agents (NTAs), toxic industrial chemicals (TICs), toxic industrial materials (TIMs)] as specified in the TEMP.

b. Simulants to be used are specified in the test plan. Simulants may be prepared with a suitable dye or thickener.

#### 4.1.5.9 SUT Preparation.

Sample locations will be marked to ensure samples are taken from the same area. The area markings should outline the total area. Sample location identifiers should be outside the marked area.

#### 4.1.5.10 Test Chamber Operation.

The test chamber will be operated using the procedures, controls, and SOPs approved for the agent in use. Some general technical data requirements for the test chamber are as follows:

- a. The test chamber environmental conditions should be computer-monitored, and data should be recorded at least every 15 minutes. The environmental conditions will include air temperature, RH, wind speed or air speed, SUT surface temperature, and differential pressure (chamber versus atmospheric).
- b. The SUT will be placed in the chamber and the chamber stabilized at the environmental conditions specified for the test. The SUT will be conditioned until it has stabilized at  $30 \pm 5$  °C. Temperature and RH should be recorded continuously throughout the test.
- c. If an item is too large to fit properly in a chamber, testing may be conducted outdoors. Temperature, RH, and wind speed will be recorded throughout the test; however, they cannot be controlled. Testing will be conducted when meteorological conditions are as close to the optimum conditions as possible.
- d. Before proceeding to agent application or contamination, background swab and vapor samples should be taken from or near areas designated for contamination testing. The sampling and analysis must be tailored to detect materials that could interfere with the chemical analysis for the agent being used.

#### 4.1.5.11 Agent/Simulant Application.

- a. The mechanism for determining the actual amount of agent or simulant used to contaminate the SUT is called baseline contamination samples or baseline confirmation samples. The data collected from these samples will provide confidence that the agent/simulant dissemination method performed well and also provide the value for initial contamination ( $C_i$ ) when calculating the decontamination efficacy (in percent) –  $(C_i - C_d)/C_i \times 100$ ; where  $C_d$  is the residual contamination after decontamination operations. The selection of the appropriate deposition sampling cards (outdoor testing only) or baseline samplers is dependent on a test site's capability for providing and analyzing the samplers. The samplers will be placed on or adjacent to the SUT when drop sizing and contamination density confirmations are required. The samplers will be placed in an area that will be representative of the surface that will be contaminated. If the SUT is very large, then multiple baseline samplers should be used to provide an estimate of the total coverage.

b. The selected areas of the SUT will be contaminated with agent or simulant. The contaminant will be applied with a suitable dissemination device that has been calibrated and operated at the flow rate and pressure to achieve the drop size and contamination density specified in Paragraph 4.1.2.2.a and/or the test plan. Precision dissemination device (e.g., pipette) calibration should be current and compliant with the required performance specifications listed in the most current versions of the International Organization for Standardization (ISO) 8655 Parts 1 and 2<sup>24</sup> or American Society for Testing and Materials (ASTM) E1154-89<sup>25</sup> for the volumes being delivered. Contaminating areas of the SUT beyond the areas selected for sampling must be avoided.

c. Drop size and contamination density samplers will be removed. The contamination density samplers will be placed in a container with the appropriate type and quantity of solvent, sealed tightly, labeled, and transported to a chemical laboratory for analysis. The drop-size sampling cards will be placed in a carrying tray and, depending on the type of card and agent used, either immediately processed or allowed the predetermined time for the drops to spread. Count and size data will be collected with the appropriate instruments and/or computer software.

#### 4.1.5.12 Decontamination of the SUT.

a. Standard procedures, decontaminants, and equipment (see Paragraph 2 of FM 3-11.5<sup>26</sup> and Appendix A) and/or any SUT-specific procedures, when supplied as part of the test-documentation package (e.g., technical manual), will be used. A summary of decontamination procedures is in Appendix B.

b. A C/D cycle consists of the contamination event, the weathering period (representing travel time) and the decontamination procedure.

c. Decontamination of the SUT will proceed when any required weather time is complete (e.g., 60 minutes).

d. Decontamination will begin with areas contaminated first and end with areas contaminated last.

e. The thorough decontamination process includes the following steps:

(1) Equipment preparation, usually consisting of a HSW wash-down.

(2) Application of the decontaminant. Application of all currently fielded decontaminants requires brushing or scrubbing (reference 26).

(3) Decontaminant contact time (default is 30 minutes, but varies by decontaminant; some decontaminants may require continual application to remain wet throughout contact time (reference 26).

(4) Post-decontamination clean water rinse to remove residual decontaminant and contaminant.

(5) Point detector monitoring for residual contamination.

f. All times for each phase of the procedure should be recorded, except the time to monitor for residual contamination.

g. Decontamination procedures should be performed as if the entire surface of the test item were contaminated. The contaminated sampling areas should receive no more or no less attention, time, or effort than uncontaminated areas. Appropriate time should be spent on angles and hard-to-work areas.

h. Decontamination procedures must be documented. Video documentation is recommended, but still photographs can be used.

4.1.5.13 Post-decontamination Sampling.

a. Vapor Sampling.

(1) When the surfaces of the sampling areas are no longer visibly wet after the clean water rinse, vapor sampling can begin. Because it is difficult to sample the vapor from the entire surface of a large item, vapor samples can be taken at representative locations for extrapolation to the total surface area of the SUT.

(2) Samples will be taken at appropriate intervals that total the duration of the mission time described in the CONOPS. Generally, more agent/simulant vapor will be given off during the first few hours of sampling and slowly decrease over time. Thus, sampling intervals should be short in the beginning and longer sampling intervals later, when using cumulative sampling devices (bubblers or SSTs). This will avoid saturating any sampling device. A minimum of two SSTs should be obtained for any time interval (three samples are desirable), with the second sampler serving as a backup to the first sampler. A vapor-sampling sequence must be specified in the test plan. MINICAMS<sup>®</sup> are near real-time (NRT) samplers, and the sample time setting selected will be determined to avoid saturating the detector.

b. Agent Contact Sampling.

(1) Locations on the SUT will be sampled where direct contact with the operator's skin or hands or prolonged contact with other clothed body parts is expected.

(2) Contact samplers (a thin disk of silicone rubber ((1 mm thick)) or other suitable material) will be prepared with a nominal size of 10 to 25 cm<sup>2</sup>. Any material used for a contact sampler must be free of powder. The contact sampler should be backed by aluminum foil (see Figure 1) to prevent contamination of the weight and then by a material such as sponge rubber to force contact with all surface irregularities. The assembled sampler will be placed on the selected area creating a pressure evenly applied of 0.05-0.07 kg/cm<sup>2</sup> (or 0.7-1.0 psi) for 15 minutes. For the 2-in diameter sampler, this is equivalent to a 2-in diameter cylindrical mass weighing 1 kg. Additional contact samplers can be sequentially placed on the same area, for

selected intervals of time up to a total of 60 minutes. A slight rocking motion may be required to apply sampling force more uniformly to surfaces that are slightly curved.

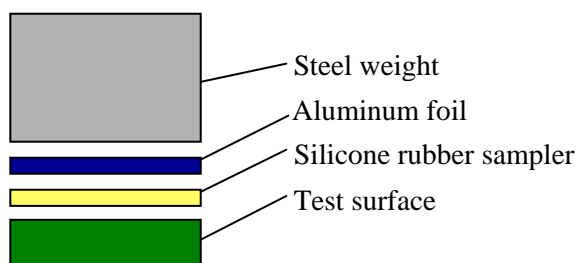


Figure 1. Diagram showing arrangement of test surface, silicone rubber disk, and steel weight for residual chemical agent liquid sampling.

(3) After reaching the appropriate time interval, the contact sampler will be immediately removed. The sampler will be placed in a sample jar filled with the appropriate type and quantity of solvent; the jar will then be sealed and transported to a chemical laboratory for analysis.

(4) The 0-hour sample shall be taken immediately after the decontamination rinse has dried. Samples shall be taken at intervals determined in the test plan as necessary for the specific CONOPS of the SUT (e.g., how long a human might be expected to lean on, touch, hold, etc., the area sampled).

c. **Sample Analysis.** Sample analysis should use analytical instruments and methods that give precise and accurate values for the primary data parameters (see SOPs WDC-ANA-004, WDC-WIN-009<sup>27</sup>, WDC-ANA-032<sup>28</sup>, WDC-ANA-033<sup>29</sup>). Data from military chemical alarms, detectors, detector papers, and kits (which provide only qualitative yes/no answers) should be used to complement data obtained from more precise analytical instruments.

#### 4.1.5.14 Hardness Determination.

a. After completion of all decontamination and sampling procedures, all surfaces of the SUT will be inspected for visible evidence of leakage and degradation caused by the agents, decontaminants, and decontaminating procedures. Other signs of material degradation may include corrosion, peeling paint, discoloration, brittleness of rubber components, hazing or yellowing of plastic components, etc. Any degradation must be described and documented with photographs.

b. The SUT must be operated IAW the appropriate manual. ME functional performance characteristics must be measured and recorded. Each parameter must be measured at least twice. Any visible evidence of operational degradation will be recorded. The hardness and ME performance data collected must be comparable with the pretest values recorded (Paragraph 4.1.5.7.c).

c. Hardness data collection should be performed after each C/D cycle and 30 days (or the specified time interval in the test plan) after the first contamination. Hardness data must be sufficiently accurate and precise to define any degradation after each C/D cycle and the specified time period.

#### 4.1.6 Data Reduction and Presentation.

##### 4.1.6.1 Receipt Inspection.

a. All data on item damage, missing components, surface condition, other discrepancies, and SUT history must be reported. Results will be summarized and presented in tabular form, emphasizing deviations from developer specifications and surface cleaning or maintenance performed.

b. Mock-up receipt-inspection data will be reported, noting differences between the mock-up and the SUT.

c. Data pertaining to surface materials and their finishes will be reported in a form that can be compared with pretest and posttest hardness functional performance data.

##### 4.1.6.2 Decontaminability.

a. Chemical decontaminability will be determined by comparing posttest residual hazards with established criteria for each agent (Paragraph 4.1.2.1). The item will be considered chemical agent decontaminable if residual vapor and contact hazards are reduced to levels at or below the established decontamination criteria (reference 10).

b. Each sampling area, including the location, material of construction, surface geometry, and surface texture, will be described. Each description will cite the contaminant, contamination procedure, decontaminant, and the decontaminating procedures used, including item-specific procedures and time expended on each procedure. A description of the pertinent information will be included in the test report. Decontamination operation video coverage and/or any still photographs taken will be made available.

c. A summary and table of the chamber conditions during the test period will be created. The agent physical properties, agent contamination density, and the drop size for each item or sampling area will be presented. Deviations from specified values will be identified.

d. The quantity of agent recovered from each agent contact sampler, identified by the location and time at which the sample was taken, will be tabulated.

e. A comparison should be made based on the area of operator skin that would contact the location sampled to determine if the hazard exists. The resulting data and hazard criterion should be represented in table format.

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f. The average concentration of agent vapor recovered from each SUT sampling location (component, if used) identified by time should be represented in table format.

g. The agent vapor mass will be run through the downwind hazard prediction model (reference 14) and the calculated dosages will be compared with the DA approved NBCCS criteria for mission-critical materiel (reference 10).

(1) No simple procedure exists for determining vapor hazard to the SUT operator(s). The credible dosage received is a function of agent desorption from the decontaminated SUT, worst-case, or other selected scenarios that have almost unlimited variables.

(2) One approach (reference 15) would be to calculate toxic load from the agent vapor dosages measured from a SUT. This approach allows the toxic load calculations to be transferred to exposure scenarios on a case-by-case basis, depending on the SUT and its expected use in the field.

h. If an area fails the decontaminability criterion, an attempt should be made to identify the material composition responsible for the failure. Failure of the decontaminability criterion may necessitate the testing of individual materials.

i. The statistical analyses conducted on all test results will be presented.

#### 4.1.6.3 Hardness.

a. All ME function performance data, identified by test-cycle number, agent, and decontaminant, will be summarized and tabulated.

b. ME function performance data for each C/D cycle will be compared with the receipt inspection performance data. The ME performance data and operator interview data will be used to determine whether more than 20 percent degradation in item performance (or that specified by the combat developer) has occurred (Paragraph 4.1.2.1 a). Significant results should be highlighted and discussed.

#### 4.1.7 Adapting to Simulant Testing.

a. Generally, the data requirements, facilities, and procedures for simulant testing will be similar to those used for toxic-agent testing. The major differences will be in the level of required safety and environmental protection restrictions as well as the reduced approval requirements for test chamber work using simulant rather than those required for toxic agent work. Simulants must be used when a test is performed by Soldier, operator, maintainer, tester, and evaluator (SOMTE) personnel; when toxic test facilities are not available; when the nature of the equipment being tested makes the use of chemical agents impractical; or when an out-of-doors test setting is required. However, testing with simulants will only determine the effects of the decontaminant and the decontamination procedures. Any adverse effects that could be caused by chemical agents would not be determined or subject to evaluation.

b. Many SUTs that fail hardness testing fail not because of the agent contamination, but because of the wetting and/or corrosive action of the decontamination solutions and/or decontamination procedures on delicate optical, electronic, and mechanical components. However, when performing decontaminability tests using simulants (even with a validated agent/simulant relationship established), determination of residual hazard after decontamination loses some relevance and may require agent testing for a final determination of decontaminability. An analysis must be performed for the specific combination of SUT, simulant, and decontamination procedure to determine if simulant testing adequately demonstrates survivability.

#### 4.1.7.1 Facilities and Instrumentation.

a. The facilities required for simulant testing are the same as for agent testing, except for the test chamber and personnel protection requirements. The chamber size, environmental controls, and instrumentation will be the same as for agent work; however, simulant testing usually requires less stringent safety and environmental protection equipment, and approval for testing will be needed.

b. Although the instrumentation required for simulant testing will generally be the same as for agent testing, different sampling equipment and procedures may be required.

c. Simulant use makes outdoor testing possible. Under these conditions, the requirement for a test chamber is eliminated, but the need for other facilities and instrumentation remains unchanged.

(1) Outdoor testing will require that the acceptable temperature, RH, and wind speed limits are expanded to cover the variability expected during the test period. Deviations from requirements in Paragraph 2.2 should be documented. In addition, other environmental parameters will have to be included in the test plan, such as limits on precipitation, dew, solar radiation (sunshine), and cloud cover.

(2) Outdoor testing will result in more realistic environmental test conditions, but will complicate data analysis and comparison of test data sets.

#### 4.1.7.2 Procedures.

Most aspects of simulant testing procedures will be the same as for agent testing. These include objectives, criteria, controls and limitations, data required, receipt inspection, pretest preparation, test-chamber operation, SUT contamination, and SUT sampling. Safety procedures may be somewhat relaxed when working with simulants; however, test controls, test procedures, and data collection should be emphasized just as rigorously as when conducting agent testing.

#### 4.1.7.3 Agent/Simulant Selection.

a. The selection of chemical compounds to simulate chemical agents is a critical step in testing with simulants. The SUT materials of construction and candidate simulant will be

examined and compared with the CBME database to ensure compatibility, i.e., that no degradation will be caused by the simulant that would not be caused by agent. The simulants selected should be safe to handle and require minimum protective gear, equipment, and procedures; cause little or no environmental concern; and require minimum handling and storage problems.

b. Simulants selected for hardness testing should have volatility, viscosity, and surface tension values similar to the simulated agent; require approximately the same mechanical energy to remove from surfaces; and be easily seen when applied in the appropriate drop size. Such simulants must also simulate the probability of damage to mechanical, optical, electrical, or thermal properties by the agent. Even if a simulant adequately mimics all of these properties, there is no assurance that the simulant will have the same effect on the SUT as chemical agent.

c. Simulants selected for decontaminability testing must closely match the selected properties listed in Paragraphs 4.1.7.3.a and b. Selected simulants must have similar chemical interactions with the decontaminants used, solubility in the decontamination solution, and have a sensitive laboratory analysis procedure. Decontaminability and residual hazard data lose relevance without adequate side-by-side agent/simulant comparison data to confirm test procedure validity. Such agent/simulant comparison data must be obtained in a laboratory study. Experience has demonstrated that no single compound will simulate all of the important properties of an agent. Performing replicate decontaminability tests using two or more simulants with different properties on each test may be needed to meet selected data requirements.

#### 4.1.7.4 Decontamination.

The procedures used during decontamination will be the same as those used for agent testing; however, the chemical reaction between the simulant and the decontaminating solution will not be the same or may not proceed at the same rate as with the actual chemical agent.

#### 4.1.7.5 Sampling and Analysis.

The sampling devices used to sample the simulant should be selected to be as sensitive as those used in chemical agent testing. The analytical procedure must be able to identify and measure the simulant to the same sensitivity as the chemical agent for which the simulant is a surrogate.

### 4.2 Biological Contaminant Survivability.

#### 4.2.1 Objectives.

a. Decontaminability. The ability of a system to be rapidly (in less than 75 minutes) (reference 10) and effectively decontaminated will be determined following exposure to an ABO or simulant. The associated hazard will be measured on equipment that has been contaminated with biological contaminant and decontaminated using standard and/or item-specific decontamination procedures.

b. Hardness. The capability of a system to withstand the material damaging effects of biological agent and/or relevant decontaminations will be determined. The degree of performance degradation will be measured in ME functions of military mission-critical materiel after biological agent C/D by standard and/or item-specific procedures.

#### 4.2.2 Criteria and Conditions.

##### 4.2.2.1 Criteria.

a. Decontaminability. After decontamination, residual contamination levels for the equipment must constitute a negligible risk to unprotected users of the equipment (reference 11). In the determination of biological survivability, the following CBCS test conditions apply.

b. Hardness. Materiel developed to perform ME functions shall be hardened to ensure that exposure to the specified CB C/D cycles does not degrade the ME performance of the equipment more than 20 percent or that specified by the combat developer measured over a specified time or mission duration. The number of C/D cycles for biological survivability should consider pandemic events and the requirements imposed by the affected countries.

##### 4.2.2.2 Conditions.

a. General Conditions. The time frame to start decontamination depends on test plan requirements. Standard field and/or item-specific decontaminants, equipment, and procedures will be used.

b. Detailed Conditions. If not already specified in the capabilities document, the detailed chamber conditions (reference 10) for biological contamination survivability testing will be as follows:

- (1) Chamber temperature:  $30 \pm 5$  °C.
- (2) RH: ambient  $\pm 2$  percent.
- (3) Test chamber air circulation:  $\leq 1$  m/sec.
- (4) Exterior contamination density:  $1 \pm 0.5 \times 10^7$  CFU/m<sup>2</sup>, or at least  $2 \times 10^4$  CFU/25 cm<sup>2</sup>.
- (5) Particle size: 1 to 5 µm.

c. Outdoor testing will use ambient conditions chosen to be as close as possible to the chamber conditions. The contamination density and particle size will remain the same.

#### 4.2.3 Controls and Limitations.

The controls and limitations for the SUT and sample analysis controls of biological agent contamination survivability testing are as follows:

a. SUT Controls.

(1) Paint type, specifications, and application must comply with system specification for the SUT.

(2) Surface areas selected for sampling must be representative of the exterior surface paint, materials, texture, and the areas where the user will have direct contact.

b. Sample and Analysis Controls.

(1) Swab control (unused swab).

(2) Swab of a noncontaminated surface.

(3) Diluent control.

(4) Plate control.

(5) A maximum of 18 hours between sample collection and culturing.

#### 4.2.4 Data Required.

a. Test Chamber/Hood or Outdoor Environmental Conditions.

(1) Temperature in °C.

(2) RH in percent.

(3) Wind speed (airflow around the SUT) in m/sec.

b. Agent or simulant.

(1) Name, control number, and spore manufacturer.

(2) Diluent used.

(3) Percent solids.

(4) Date prepared and/or reconstituted.

(5) Date used.

- (6) CFU per mL.
  - (7) Disseminator used.
  - (8) Quantity of agent/simulant suspension disseminated in mL.
  - (9) Disseminator air pressure in pounds per square inch (psi).
  - (10) Still color photographs and written description of each area contaminated.
  - (11) Contamination density for each sampling area (including background) before and after decontamination, expressed in CFU/sample.
- c. Sample history with elapsed time to analysis in hours.
  - d. Elapsed time required to complete contamination, weathering time before decontamination, decontamination time, and time each sample will be taken in minutes.
  - e. Description of the decontamination solutions (i.e., formulation, active ingredients, and age), methods, equipment, lot number, and item-specific procedures used.
  - f. Description of SUT exterior materials of construction, paint type, and surface condition (pretest and posttest), including cleanliness (mud, grease, and other). Photographs should be made of joints, crevices, textures, or other areas that may be difficult to decontaminate or allow liquid to penetrate.
  - g. Pretest and posttest ME functional performance characteristics used as the measure of the SUT's mission performance before and after exposure to contaminants, decontaminants, and decontaminating procedures.
  - h. Results of posttest operator questionnaires and comments (outdoor testing only).
  - i. Description of any safety issues.

#### 4.2.5 Methods and Procedures.

##### 4.2.5.1 Test Method Outline.

- a. The agents/simulants are prepared for application. Paragraph 4.2.5.5 describes the details for this step of the test method.
- b. Receipt inspection is conducted on the SUT to document as tested material conditions. Receipt inspection may include functional performance tests to establish baseline performance parameters (e.g., computer is operational, aircraft avionics are operational, etc.). Paragraph 4.2.5.6 describes the details of this step.

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- c. SUT is prepared for testing to include: sample location, identification, and documentation; marking of sample areas; etc., as described in Paragraph 4.2.5.7.
- d. Disseminator Preparation. Paragraph 4.2.5.8 describes the details of this step.
- e. Test Chamber Operations. Test chamber operation will be verified and environmental conditions for the test stabilized (if test is conducted in a chamber). If an item is too large to fit properly in a chamber, testing may be conducted outdoors. Environmental conditions are monitored, the SUT allowed to equilibrate with the ambient conditions, and background samples are taken before contamination. Paragraph 4.2.5.9 describes the details of this step.
- f. Agents/simulants are applied to the item under test IAW Paragraph 4.2.5.10.
- g. Post-contamination samples (contamination density verification) will be taken as described in Paragraph 4.2.5.11.
- h. Decontamination operations will be conducted on the item under test IAW Paragraph 4.2.5.12.
- i. Post-decontamination sampling will be conducted IAW Paragraph 4.2.5.13.
- j. Hardness and post-decontamination functional performance measurements will be performed IAW Paragraph 4.2.5.14.
- k. Sample analysis will be performed as described in Paragraph 4.2.5.15.
- l. Data analysis and hazard determination will be performed IAW Paragraph 4.2.5.16.
- m. Significance and Use.

(1) The sample data collected from this test allow a determination of biological spore hazards to unprotected personnel from decontaminated military materiel.

(2) The functional performance and/or material effects data collected allow a determination of the amount of physical or functional degradation of the SUT resulting from CBR contamination, decontamination procedures, and materials, to determine if there is a hardness issue.

#### 4.2.5.2 Interferences.

- a. There are no interferences when the test method is conducted under laboratory-controlled conditions.
- b. Outdoor testing is inherently uncontrolled or has extreme variances in temperature or humidity. These are constituents or properties that will create test conduct interferences.

#### 4.2.5.3 Apparatus.

- a. The term apparatus will be used to cover the test fixture in which a test method may be conducted as well as the equipment used in conducting testing, sampling, and analytical instrumentation.
- b. If the large SUT cannot fit within an existing test chamber, then testing will be conducted outdoors.
- c. The instrumentation used in test method conduct, sampling for residual biological organisms, and the analytical equipment for sample analysis are found in Paragraphs 2.2 and 2.2.2.

#### 4.2.5.4 Hazards.

- a. Follow all safety protocols to address any hazards in working with the selected biological simulants. Biological safety guidelines are found in DA PAM 385-69.
- b. There are safety issues when testing with decontaminant chemicals that are hazardous<sup>18</sup> (e.g., chlorine, hydrogen peroxide, etc.).
- c. Testing conducted on large items of equipment may also have slipping or falling hazards (reference 16) when attempting to conduct decontamination operations on the equipment.
- d. A test plan must be developed with a safety section identifying and addressing all safety concerns for each test conducted using these methods IAW AR 385-10. The safety section of the test plan will be coordinated with the test site's safety office.

#### 4.2.5.5 Biological Agent/Simulant Preparation.

- a. The rationale for the selection and use of any biological simulants and the agent/simulant relationship must be documented in the test report.
- b. Procedure controls and SOPs in effect at the time for biological simulant testing must always be followed.
- c. The simulant powder will be characterized to verify that the proper particulate size profile is met (1 to 5  $\mu\text{m}$ ).

#### 4.2.5.6 Receipt Inspection and Functional Performance.

A receipt inspection and pretest ME functional performance test, as described in Paragraph 4.1.5.7, will be performed if not previously performed as part of another test phase.

#### 4.2.5.7 SUT Preparation.

Sample locations should be marked to ensure samples are taken from the same area. For biological contamination survivability, three closely located 25-cm<sup>2</sup> sample areas for each location selected should be marked. At each sampling location, three samples will be collected: (1) background, (2) post-contamination, and (3) post-decontamination.

#### 4.2.5.8 Disseminator Preparation.

The compressed-air dry-powder disseminator should be prepared to disperse the test organism containing particles in the 1- to 5- $\mu$ m size range. For outdoor testing, the air-driven slurry disseminator should be prepared for applying organisms in the appropriate size range. The appropriate operating time, air pressure, and concentration for the disseminator must be determined. The project biologist will determine exact slurry count, the disseminator air pressure, the duration of disseminator operation, and the number of CFUs required to meet the SUT contamination target of  $1 \times 10^7$  CFU/m<sup>2</sup> or  $2 \times 10^4$  CFU/25 cm<sup>2</sup>.

#### 4.2.5.9 Test Chamber Operation.

a. The test chamber will be brought to the environmental conditions specified for the test, and the SUT will be placed into the chamber. The SUT will be temperature-conditioned for a minimum of 2 hours. The temperature, RH, and wind speed for the duration of the test will be recorded.

b. If an item is too large to fit properly in a chamber, testing may be conducted outdoors. Temperature, RH, and wind speed will be recorded; however, they cannot be controlled. Testing will be conducted when meteorological conditions are as close to the optimum conditions as possible.

c. Before proceeding to contamination of the SUT, the first 25-cm<sup>2</sup> sampling areas at each sampling location should be swab sampled to determine the background contamination level and residual substances (decontaminant) that could interfere with sample assay.

#### 4.2.5.10 Agent/Simulant Application.

a. Chamber Testing. The dry powder disseminator will be used to apply the contaminant to the SUT. One hour should be allotted for contamination to settle on the SUT. After the settling, the chamber will be air-washed for 1 hour to reduce chamber contamination.

b. Outdoor Testing. The liquid slurry disseminator will be used to apply the contaminant to the SUT. After application, wait to continue the trial until the slurry has dried. This time will vary depending on ambient environmental conditions.

#### 4.2.5.11 Contamination Density Sampling.

Immediately after the air-wash, the second 25-cm<sup>2</sup> area in each sampling location should be swab sampled to determine the biological contamination density on the SUT.

#### 4.2.5.12 Decontamination of the SUT.

a. Decontamination must begin immediately after contamination density sampling. Standard decontamination procedures, solutions, and equipment, or any SUT-specific procedures furnished as part of the test documentation package, should be used. Typically, a diluted bleach/water solution (1 gallon bleach mixed into 9 gallons water gives a 10 percent dilute bleach solution) is used.

b. Decontamination procedures should be performed as if the entire surface of the SUT were uniformly contaminated. Appropriate time should be spent on rough surfaces, joints, angles, and hard-to-clean areas.

c. All decontamination procedures, equipment, tools, and time used in the decontamination process, including item-specific procedures, must be recorded.

#### 4.2.5.13 Post-decontamination Sampling.

When the SUT surface is dry following decontamination, the third 25 cm<sup>2</sup> area in each sampling location will be swab sampled to determine the residual contamination remaining on the SUT.

#### 4.2.5.14 Hardness Determination.

a. After biological decontamination is complete and the final set of swab samples has been taken, the SUT will be visually inspected for evidence of degradation (e.g., corrosion, paint peeling, yellowing of plastics, etc.) caused by the test procedures. The SUT should be operated, and all ME functional performance characteristics will be measured and recorded. Each parameter should be measured at least twice, depending on the inherent difficulty in reproducing a specific value. Post-C/D values will be compared with pretest values.

b. Any visible indication of operational degradation attributable to the biological C/D cycle(s) will be recorded.

c. After completion of the simulant or agent exposure, all surfaces of the item will be inspected for visible evidence of agent ingress or degradation caused by the agents. Degradation will be described and documented with video or photographs. The SUT will be operated in protective ensemble IAW the appropriate manual. ME functional performance characteristics will be measured and recorded. Each parameter will be measured at least twice. Test operators will be interviewed, and all evidence of operational degradation will be recorded. The hardness data collected must be comparable with the pretest values recorded (Paragraph 4.1.5.7.c).

#### 4.2.5.15 Sample Analysis.

Analysis of biological samples will be conducted IAW SOP WDL-WI-BIO-135<sup>30</sup>, Assay for Biological Simulants.

#### 4.2.5.16 Data Reduction and Analysis.

a. Each sampling area will be described (use of photographs is encouraged), including the location, materials of construction, surface geometry, and surface texture. The decontaminant, decontamination time, and decontaminating procedures used, including item-specific procedures furnished by the materiel developer, will be cited.

b. The chamber conditions during the test period will be summarized and described. A description of the test organism physical property data and aerosol disseminator operating data will be recorded. Any deviations from target values will be identified and explained.

c. For each sampling location, the following will be summarized: CFU recovered from the control samples, the SUT contamination level, and the residual sample level after decontamination, including any residual sample values obtained after subsequent decontaminations.

d. The decontamination reduction ratio achieved by the decontamination process (the challenge contamination level divided by the residual contamination level) for each sampling location will be calculated. The CFUs (spores that have become viable cells) that are sampled after decontamination will be divided by the number of CFUs sampled after contamination of the SUT. This reduction ratio will be expressed as the log reduction. The reduction ratio and the raw challenge and residual data will be presented in tabular form. The item will successfully meet the criterion (reference 10) for biological decontaminability and be considered decontaminable for biological agent if the contamination of the SUT has a 6 or greater log reduction.

e. If alternative methods or additional cycles of decontamination appear likely to improve decontamination effectiveness, they will be recommended for consideration.

f. The biological hardness determination will be the same as for chemical hardness and may be performed jointly with those described in Paragraph 4.1.5.14. The data reduction and analysis for hardness will be the same as described in Paragraph 4.1.6.3.

### 4.3 Long-Term CB Hardness.

#### 4.3.1 Objective.

The long-term (as specified in the capabilities documents, but greater than 30 days ((reference 10)) effects of CB contamination and CB decontamination procedures will be determined.

#### 4.3.2 Criterion.

None. There is no criterion for hardness determination for a time period greater than 30 days.

#### 4.3.3 Hardness Determination.

a. At the conclusion of the long-term period, the SUT will be visually inspected for evidence of corrosion caused by the test procedures. The SUT will be operated, and all ME-functional performance characteristics will be measured and recorded. Each parameter will be measured at least twice, depending on the inherent difficulty in reproducing a specific value. Posttest values will be compared with pretest values. Procedures and data required are the same as those described for chemical hardness in Paragraph 4.1.5.14.

b. Test operators will be interviewed, and any indication of operational degradation attributable to the C/D cycles will be recorded.

#### 4.3.4 Data Reduction and Analysis.

The long-term hardness determination will be the same as for chemical hardness, and procedures are the same as those described in Paragraph 4.1.6.3.

#### 4.4 CB Compatibility.

##### 4.4.1 Objective.

The capability of a system to be operated, maintained, and resupplied by persons wearing MOPP IV will be determined. The degree of degradation in ME Warfighter tasks as a result of operating a piece of equipment in protective ensemble will be measured.

##### 4.4.2 Criterion/Conditions.

###### 4.4.2.1 Criterion.

The combination of equipment and NBC protection shall permit performance of ME operations, communications, maintenance, resupply, and decontamination tasks by trained and acclimatized troops over a typical mission profile in a contaminated environment. The mission profile will not exceed 12 hours. Conduct of ME tasks in an NBC environment must be conducted without degradation, excluding heat stress, of crew performance of ME tasks greater than 15 percent below levels specified for these tasks when accomplished in a non-NBC environment (reference 10).

###### 4.4.2.2 Controls and Limitations.

a. Meteorological conditions during testing should be comparable to those areas of intended use as much as possible. Paired comparisons should be planned, thus minimizing

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meteorological conditions as a source of variation in comparing SUT performance with and without the wearing of CB protective clothing.

b. CB compatibility tests should be based on a test design that considers all variables, such as the level of operator CB training, degree of acclimatization, familiarity and experience with the equipment, and test environmental variables.

c. All operators of the equipment will be properly trained and certified to operate the test equipment.

d. Warfighters will be used in CB compatibility tests to the maximum extent possible.

e. Any crews who have been in protective ensemble (MOPP IV) must be given appropriate rest cycles (Technical Bulletin (TB) MED 507<sup>31</sup>).

#### 4.4.3 Data Required.

a. A listing of ME tasks identified by the combat developer for the equipment undergoing the CB compatibility test must indicate how each task is to be measured and whether the function is to be classified as an attribute (go, no-go) or a variable measured over a specified range.

b. Baseline ME performance characteristics for the equipment must be determined.

c. ME Warfighter tasks/equipment performance must be measured with operators in standard battledress and in CB protective clothing.

d. Temperature, wind speed, RH, light conditions, cloud cover (if outdoors), and heat stress level will be recorded throughout the testing procedure.

e. A training record, military occupation specialty (MOS) qualification score, experience with the equipment, medical or physical profile, and anthropometric data for each operator/participant will be compiled.

f. Copies of operator, supervisor, and subject matter expert (SME) questionnaires will be compiled.

g. Out-of-tolerance performance, breakdowns, or other anomalous performance occurring during compatibility tests will be documented.

#### 4.4.4 Methods and Procedures.

##### 4.4.4.1 Test Method Outline.

a. Test scenarios will be determined with the customer and/or evaluator.

- b. Each test scenario will be conducted at least once with the Warfighter(s) dressed in normal uniform.
- c. Time required to conduct the operation or each distinct portion of a total operation will be measured.
- d. Each test scenario will be conducted at least once with the Warfighter(s) dressed in protective ensemble.
- e. Time required to conduct the operation or each distinct portion of a total operation will be measured.

#### 4.4.4.2 Significance and Use.

This testing will acquire data that will allow a determination of the impact of wearing MOPP IV protective ensemble in the ability of Warfighters to perform operations and/or maintenance functions on the SUT.

#### 4.4.4.3 Interferences.

None.

#### 4.4.4.4 Apparatus.

Testing can be conducted in a variety of chambers that cannot be delineated in this document. Outdoor testing is not conducted within a chamber.

#### 4.4.4.5 Hazards.

None.

#### 4.4.4.6 Test-Site Operations.

All local, state, and federal environmental regulations will be followed.

#### 4.4.4.7 Test Planning and Preparation.

- a. A test scenario specifying functions and operations to be evaluated during a typical mission profile must be prepared. It will include a list of SUTs to be used, the type and number of Warfighters required, and the sequence of tasks to be measured. The exact measurements to be taken, the sequence in which they are taken, and the instrument or measuring device used will be clearly specified. Maximum use of video recording should be considered. The role of SMEs or field observers must be clearly explained. The scenario must ensure that all functions or tasks identified as essential are executed and evaluated.

b. A minimum of two test crews will be requested to allow battledress trials and CBR protective gear/MOPP IV ensemble trials to be conducted simultaneously, partially eliminating environmental conditions and heat stress levels as variables. A sufficient number of rehearsals must be performed to ensure that equipment familiarization is not a factor in the compatibility determination.

#### 4.4.4.8 Test Conduct.

a. Equipment Operation. Equipment to be tested will be operated and maintained in strict compliance with operating manuals, instructions, and SOPs. In performing maintenance tasks, only tools and repair procedures specified for the equipment will be used.

b. The scenario must be performed once in battledress and another time in MOPP IV. If there are double crews, then crews will be switched and the scenario repeated. The scenario must be repeated until the decision point specified in the test plan or OEP has been reached. To avoid bias on the final trial, test personnel will not be informed of the number of replicates to be conducted.

c. Any questionnaires will be completed at the conclusion of each pair of trials. Whenever possible, videotapes will be reviewed between trials to ensure that the test is meeting objectives.

d. Degradation of crew performance caused by heat stress while wearing MOPP IV or other CB protective clothing will be observed and recorded. To help avoid heat stress, trials will be scheduled at the time of day and seasons when heat stress will be at a minimum. The factors (reference 31)), together with the use of a stress meter or internal telemetry pill, will serve as guides in identifying and controlling heat stress whenever meteorological conditions (for outdoor testing) and/or level of exertion indicate that a potential heat-stress problem exists.

#### 4.4.5 Data Reduction and Analysis.

a. Crew/SUT performance data will be summarized and presented in tabular form as paired comparisons. The time taken to perform the operation with protective gear will be subtracted from the time taken to perform the operation without the protective gear. The differences in performance attributable to type of clothing worn will be highlighted.

b. If questionnaires are used (Paragraph 4.4.4.8.c), questionnaire data will be tabulated and summarized, highlighting any operational difficulties attributed to the wearing of CB protective clothing by crew members or observers. Questionnaire data for the two sets of trials will be contrasted and results reported (see Paragraph 1.4.c).

c. Meteorological data (if applicable) and heat-stress data will be summarized and presented.

d. Data gaps must be identified.

5. DATA REQUIRED.

The data requirements for each of the specific subtests are identified along with each of the subtests described in Paragraph 4.

6. PRESENTATION OF DATA.

Test information should be placed in the Automated Test Incident Reporting System (ATIRS) or other data collection system format for review by all interested parties. SUT failures will be scored by the information included in the ATIRS and the FD/SC. “Good news” test incident reports (TIRs) will present test completion milestones.

6.1 Receipt Inspection.

Decontaminability data must include a description of the as-received SUT or mock-up, identifying any damage and specific conditions of the surface to be exposed to agents, biological spores, or radiological fallout simulant. Receipt inspection photographs are important. Differences between the mock-up and the SUT must be described. Receipt inspection photographs of exterior materials, construction, paint, cleanliness, joints, and crevices will be required.

a. All data on item damage, missing components, surface condition, other discrepancies, and SUT history must be reported. Results will be summarized and presented in tabular form, including surface cleaning or maintenance performed, and emphasizing deviations from developer specifications.

b. Mock-up receipt-inspection data will be reported, noting differences between the mock-up and the SUT.

c. Data pertaining to surface materials and their finishes will be reported in a form that can be compared with pretest and posttest hardness functional performance data.

6.2 Chemical Contamination Survivability.

a. Chemical decontaminability will be determined by comparing posttest residual agent with established criteria for each agent (Paragraph 4.1.2.1). The item will be considered chemical agent decontaminable if residual vapor and contact hazard are reduced to levels at or below the established decontamination criteria (reference 10).

b. Each sampling area, including the location, material of construction, surface geometry, and surface texture, will be described. Each description will cite the contaminant, contamination procedure, decontaminant, and the decontamination procedures used, including item-specific procedures and time expended on each procedure. A description of pertinent information will be included in the test report. Decontamination operation video coverage and/or still photographs will be made.

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c. A summary and table of the hood/chamber conditions during the test period will be created. The agent physical properties, agent contamination density, and the drop size for each item or sampling area, will be presented, and deviations from specified values will be identified.

d. The quantity of agent recovered from each agent contact sampler, identified by the location and time at which the sample was taken, will be tabulated.

e. A comparison must be made based on the area of operator skin that would contact the location sampled to determine if a hazard exists. The resulting data and hazard criterion will be represented in table format.

f. The average concentration of agent vapor recovered from each SUT sampling location (component, if used) identified by time period should be represented in table format.

g. The agent vapor mass will be run through the downwind hazard prediction model<sup>18</sup> and the calculated dosages will be compared with the DA approved NBCCS criteria for Army materiel (reference 10).

(1) No simple procedure exists for determining vapor hazard to the SUT operator(s). The credible dosage received is a function of agent desorption from the decontaminated SUT, worst-case or other selected scenarios that have almost unlimited variables, and the established “no effects” criteria.

(2) One approach (reference 19) would be to calculate toxic load from the agent vapor dosages measured from a SUT. This approach allows the toxic load calculations to be transferred to exposure scenarios on a case-by-case basis, depending on the SUT and its expected use in the field.

h. Failure of the decontaminability criterion may necessitate the testing of individual materials. When individual materials are tested for changes in materials properties, the properties matrix in Appendix C will be used.

i. When three or more identical SUTs are used in any C/D cycle, statistical analyses conducted on all test results will be presented.

j. All ME function performance data, identified by test-cycle number, agent, and decontaminant, will be summarized and tabulated.

k. ME function performance data for each C/D cycle will be compared with the receipt inspection performance data. The ME performance data and operator interview data will be used to determine whether more than 20 percent degradation in item performance (or that specified by the combat developer) has occurred (Paragraph 4.1.2.1.b). Significant results will be highlighted and discussed.

### 6.3 Biological Contamination Survivability.

a. Each sampling area will be described (inclusion of photographs is encouraged), including the location, materials of construction, surface geometry, and surface texture. The decontaminant, decontamination time, and decontamination procedures used, including item-specific procedures furnished by the materiel developer, will be recorded.

b. The chamber conditions during the test period will be summarized and described. A description of the test organism physical property data and aerosol disseminator operating data will be recorded. Any deviations from target values will be identified and explained.

c. For each material/location, the following will be summarized: the CFU recovered from the control samples, the chamber air-contamination level, the SUT contamination level, and the residual sample level after decontamination, including any residual sample values obtained after subsequent decontaminations.

d. The decontamination reduction ratio achieved by the decontamination process (the item challenge contamination level divided by the residual contamination level) for each sampling location will be calculated. The CFUs (spores that have become viable cells) that are sampled after decontamination will be divided by the number of CFUs sampled after contamination of the SUT. This reduction ratio will be expressed as the log reduction. The reduction ratio and the raw challenge and residual data will be presented in tabular form. The item will successfully meet the criterion (reference 10) for biological decontaminability and be considered decontaminable for biological agent if the contamination of the SUT has a 6 or greater log reduction.

e. The biological hardness determination will be the same as for chemical hardness and the procedures are the same as those described in Paragraph 4.1.5.14.

### 6.4 Long-Term CB Hardness.

Hardness data will be presented in a format to show direct comparison of pre and posttest exposure ME function performance of the SUT.

### 6.5 CB Compatibility.

a. Comparison data of crew performance (while wearing regular battledress and protective ensemble) will be presented (time to perform each function) in tabular form.

b. Questionnaire data will be summarized in narrative form highlighting crew difficulties.

c. Meteorological (if applicable) and heat-stress data will be tabulated.

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## APPENDIX A. TEST EQUIPMENT

Thermocouple.

Humidity Probe.

Anemometer.

Still color camera.

Video camera.

Bubblers, MINICAMS<sup>®</sup>, SSTs, or equivalent.

GC, HPLC, LC, spectrophotometer, or equivalent.

Silicone rubber, latex dental dam or equivalent.

Compressed air dry powder disseminator.

Air-driven liquid-slurry disseminator.

Microscopes, automatic colony counters or equivalent, swabs or wipes placed in growth medium.

Stop watches or equivalent.

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## APPENDIX B. SUMMARY OF DECONTAMINATION SYSTEM PROCEDURES

The following decontamination system procedures are a summary from FM 3-11.5 for Army and Marine Corps. The M291 skin decontamination kit (SDK) is not described in this appendix because it is only fielded for use on skin, and this is not pertinent to CBRCS.

<u>Decontamination System</u>	<u>General Procedure for Use</u>	<u>General Equipment Procedures</u>
M295 Individual Equipment Decontamination Kit	The kit is to be placed on the hand and patted on the surface of the equipment being decontaminated. Scrubbing motions should not be used because it may clog the mitt material and prevent distribution of the sorbent powder. The powder should be removed from the equipment by brushing, wiping, or high-pressure air.	This kit is only issued for use on a Warfighter's individual equipment. The sorbent powder in this kit will absorb all liquids including lubricants. Any lubricated personal equipment (e.g., rifle) will need to be cleaned and lubricated before use. This kit is for immediate decontamination.
M100 Sorbent Decontamination System	When the kit is opened, there are two packets with sorbent powder and two mitts included. A sorbent powder packet should be carefully opened, and the contents placed onto the mitt palm. The mitt is then used to apply sorbent powder onto equipment using patting or scrubbing motions. Additional powder is applied to the mitt as necessary. The second packet may be necessary for continued decontamination efforts.	This system is issued to vehicles and other systems, not to personnel. The sorbent powder in this kit will absorb all liquids including lubricants. Any lubricated equipment will need to be cleaned and lubricated before use. This system is to be used for operational decontamination.
M17	This system is used to apply HSW and/or a high-pressure clean water rinse.	This system will most likely to be used at a thorough decontamination site.

## APPENDIX B. SUMMARY OF DECONTAMINATION SYSTEM PROCEDURES

<u>Decontamination System</u>	<u>General Procedure for Use</u>	<u>General Equipment Procedures</u>
M12	<p>This system is used to apply low-pressure high-volume water for equipment pre-rinse, STB slurry, HSW and HTH solution. The low-pressure high-volume pre-rinse will be performed before decontaminant application. The STB slurry or HTH solution will be applied to vehicles or equipment and an individual with a scrubbing brush will follow closely so that the slurry/solution is not allowed to dry. This operation is conducted on both sides of a vehicle simultaneously, using two M12s. If the air temperature is too high, additional applications of the slurry/solution may need to be applied to maintain decontaminant/agent contact.</p>	<p>An M12 is only used at a thorough decontamination site. Before the start of decontamination procedures, each equipment system that goes through thorough decontamination may require components to be removed and/or components (e.g., lenses) protected (covered) from the effects of decontaminants. After decontamination has been verified, components that have been removed will most likely need to be replaced with new components. Protected components must be separately decontaminated with the appropriate decontamination for that component.</p>
M26 Joint Service Transportable Decontamination System-Small Scale (JSTDS-SS)	<p>This system will be used to apply water and HSW to perform operational decontamination missions and support thorough decontamination operations. It may also be used to support clearance decontamination missions, limited facility decontamination, and/or terrain decontamination.</p>	<p>This system is most likely to be used at the site of a system's operational decontamination.</p>

## APPENDIX C. MATERIAL PROPERTIES MATRIX AND DATA TEMPLATE

The material properties matrix provides a useful tool for program managers, testers, and database developers to acquire the information needed to ensure that defense systems are survivable to the effects of CB contamination and the decontamination process. This matrix details the critical properties of materials that program managers and testers should test to determine if mission-critical systems are survivable in a CB environment by measuring any significant degradation to these critical properties. While survivability determinations are not limited to the materials and properties listed in this matrix, it provides a minimum framework for data that program managers and testers should provide to the CBME database<sup>6</sup> so that appropriate survivable materials can be selected during the design of new systems or system upgrades.

TABLE C-1. MATERIALS AND PROPERTIES OF INTEREST

Properties			Metals	Laminates	Adhesives/Sealants/ Joints (Including Welds)	Coatings	Potting Compounds	Optical Materials (Metal Oxides, Plastics, etc.)	Elastomers	Plastics	Composite Materials	Petroleum, Oil, and Lubricants (POL)	Textiles	Ceramics
Agent Effects	1	Agent absorption ( $\mu\text{g}/\text{cm}^2$ absorbed per time period) and agent desorption ( $\mu\text{g}/\text{cm}^2$ desorbed per time period)		X	X	X	X	X	X	X	X		X	X
	2	Permeation (time to breakthrough of agent)/penetration of vapors and liquids			X	X	X		X	X			X	X
	3	Weight change	X	X	X	X	X	X	X	X	X		X	X
	4	Density	X	X	X	X	X				X			X
	5	Off gassing (vapor)	X	X	X	X	X	X	X	X	X		X	X
	6	Contact hazard (liquid)	X	X	X	X	X	X	X	X	X		X	X
Mechanical Properties	7	Elastic modules	X	X	X				X	X	X			
	8	Tensile Properties (yield strength, ductility)	X	X	X		X	X	X	X	X		X	X
	9	Hydrogen embrittlement	X	X	X	X								
	10	Ultimate strength for tension (flexural)		X	X									
	11	Compressive strength	X	X	X			X		X	X			X
	12	Shear strength	X	X	X		X			X	X			X
	13	Fracture toughness (compression, bending, tensile, shear, impact)	X	X	X	X	X	X	X	X	X			X
	14	Hardness (indentation, durometer, scratch resistance)	X	X	X	X	X	X	X	X	X		X	X
	15	Resilience (capacity to absorb energy elastically)	X	X					X	X	X			X
	16	Fatigue strength (includes adhesives for structural bonds)	X	X	X					X	X			X
Mechanical Properties	17	Puncture resistance							X	X	X		X	X
	18	Creep (rupture) strength	X	X	X					X	X			
	19	Compressive spring constant							X		X			
	20	Bond strength	X	X	X						X			X

TABLE C-1. CONTINUED

Properties			Metals	Laminates	Adhesives/Sealants/ Joints (Including Welds)	Coatings	Potting Compounds	Optical Materials (Metal Oxides, Plastics, etc.)	Elastomers	Plastics	Composite Materials	Petroleum, Oil, and Lubricants (POL)	Textiles	Ceramics
POL Properties	21	Thermal stability										X		
	22	Chemical compatibility										X		
	23	Lubricity										X		
	24	Solubility										X		
	25	Melting point/boiling point										X		
	26	Viscosity										X		
Physical Properties	27	Dimensional change	X	X	X	X	X	X	X	X	X		X	X
	28	Color change (discoloration, surface finish)	X	X	X	X	X	X	X	X	X		X	X
	29	Optical clarity/distortion (haze, transmittance, reflectance)				X		X		X				X
	30	Crazing, stress, corrosion, cracking	X	X	X	X	X	X		X				X
	31	Acoustic dampening		X		X					X			
	32	Glass transition temperature		X	X			X	X	X	X			X
	33	Rubber property-effects of liquids							X					
	34	Peel/lap shear strength change		X	X	X					X			
	35	Adhesion (loss of), blistering, spalling		X	X	X	X				X			X
	36	Corrosion rate	X	X	X						X			X
Thermal Properties	37	Thermal conductivity	X	X	X	X	X			X	X			X
	38	Flame resistance		X	X			X	X	X	X		X	X
	39	Flash point/ignition temperature			X	X						X	X	
Electrical Properties	40	Insulative properties (including dissipation factor)		X		X	X		X	X	X			X
	41	Dielectric constant		X	X	X	X	X	X	X	X			X
	42	Electrical conductivity	X	X	X	X	X		X	X	X			
	43	Impedance	X	X	X	X	X		X	X	X			
	44	Relative permittivity		X		X				X	X			X
	45	Polarizability (effect on radar signals)		X		X				X	X			X

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## APPENDIX D. EXPLANATION OF TERMS

Capability Document. A document that captures the capabilities specific to the initial concept, development, or production of a program.

Capability Development Document (CDD). A document that captures the information necessary to develop a proposed program(s), normally using an evolutionary acquisition strategy. The CDD outlines an affordable increment of militarily useful, logistically supportable, and technically mature capability.

Capability Production Document (CPD). A document that addresses the production elements specific to a single increment of an acquisition program.

Chemical Biological (CB) Compatibility. The capability of a system to be operated, maintained, and re-supplied by persons wearing a full complement of individual protective equipment, in all climates for which the system is designed and for the period specified in the CDD or CPD.

CB Decontaminability. The ability of a system to be rapidly and effectively decontaminated to reduce the hazard to personnel operating, maintaining, and resupplying it.

CB Decontamination. The process of making material safe by absorbing, destroying, neutralizing, rendering harmless, or removing chemical or biological agents and contamination.

CB Environment. The environment created by chemical or biological contamination.

CB Hardness. The capability of material to withstand the material-damaging effects of CB contamination and relevant decontaminations.

Chemical, Biological, Radiological (CBR) Contamination Survivability (CBRCS). The capability of a system to withstand CBR contaminated environments, decontaminants, and decontamination processes, without losing the ability to accomplish the assigned mission. A CBR-contaminated survivable system is hardened against CB agent(s) or radiological contamination and decontaminants. It can be decontaminated, and is compatible with individual protective equipment. CBRCS may be accomplished by hardening, timely re-supply, redundancy, mitigation techniques (to include operational techniques), or a combination thereof. The elements of CBRCS covered by this TOP are compatibility, decontaminability, and hardness.

Chemical, Biological, Radiological, and Nuclear (CBRN) Survivability. The capability of a system to avoid, withstand, or operate during and/or after exposure to a CBR environment (and relevant decontamination) and a nuclear environment, without losing the ability to accomplish the assigned mission. CBRN survivability is divided into CBR survivability, which is concerned with CBR contamination to include fallout, and nuclear survivability, which covers initial nuclear weapon effects including Electromagnetic Pulse (EMP).

Combat Developer. A category of sponsor responsible for drafting, staffing, and revising capabilities documents.

## APPENDIX D. EXPLANATION OF TERMS

Initial Capability Document (ICD). Documents the need for a materiel approach or an approach that is a combination of materiel and non-materiel to satisfy a specific capability gap(s). It defines the capability gap(s) in terms of the functional area, the relevant range of military operations, desired effects, time, and doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF) and policy implications and constraints. The ICD summarizes the results of the DOTMLPF analysis and approaches (materiel and non-materiel) that may deliver the required capability. The outcome of an ICD could be one or more joint DOTMLPF change recommendations or CDDs.

Material Developer. The organization responsible for research, development, and acquisition of material systems in response to capabilities documents.

Mission Critical System. A system whose operational effectiveness and operational suitability are essential to successful mission completion or to aggregate residual combat capability. If this system fails, the mission will likely not be completed. Such a system can be an auxiliary or supporting system, as well as a primary mission system.

Neutron-Induced Gamma Activity. The radioactivity of elements, typically in soil, induced by neutrons produced by a nuclear burst. The induced radioactivity produces gamma and beta radiation.

Sponsor. The organization responsible for drafting, staffing, and revising capabilities documents. For this document, sponsors include Combat Developers.

System Threat Assessment. A predecessor document that is used to summarize in a CDD the projected threat environment and the specific threat capabilities to be countered. The summary includes the nature of the threat, threat tactics, and projected threat capabilities (both lethal and nonlethal) over time.

## APPENDIX E. ABBREVIATIONS

μL	microliter
ABO	agent of biological origin
AD No	accession number
APG	Aberdeen Proving Ground
AR	army regulation
ASTM	American Society for Testing and Materials
ATIRS	Automated Test Incident Reporting System
ATP	Allied Tactical Publication
C/D	contamination/decontamination
CAPAT	Chemical Detection Point and Standoff Capability Area Process Action Team
CARC	chemical agent-resistant coating
CB	chemical and biological
CBCS	chemical and biological contamination survivability
CBME	chemical and biological materials effects
CBR	chemical, biological, and radiological
CBRCS	CBR contamination survivability
CBRN	chemical, biological, radiological, and nuclear
CBRNIAC	Chemical, Biological, Radiological, and Nuclear Information Analysis Center
CBRNCS	CBRN contamination survivability
CDD	capability development document
CFU	colony forming units
Ci	initial contamination
CONOPS	concept of operations
CPD	capability production document
CS	contamination survivability
cSt	centistoke
CWA	chemical warfare agent
DA	Department of the Army
DoD	Department of Defense
DoDI	DoD Instruction
DOTMLPF	doctrine, organization, training, materiel, leadership and education, personnel and facilities
DPG	US Army Dugway Proving Ground
DTC	US Army Developmental Test Command
DTIC	Defense Technical Information Center
ECBC	Edgewood Chemical Biological Center
EMP	electromagnetic pulse
FD/SC	failure definition/scoring criteria
FM	field manual
GAO	Government Accountability Office
GC	gas chromatograph

## APPENDIX E. ABBREVIATIONS

GD	soman
HD	distilled mustard
HPLC	high-performance liquid chromatograph
HSW	hot soapy water
HTH	high-test hypochlorite
IAW	in accordance with
ICD	initial capabilities document
ISO	International Organization for Standardization
JSTDs-SS	Joint Service Transportable Decontamination System—Small Scale
LC	liquid chromatograph
ME	mission-essential
MIL-STD	military standard
MINICAMS <sup>®</sup>	a miniature, automatic, continuous air-monitoring system
MMD	mass median diameter
MOPP IV	mission oriented protective posture, level IV
MOS	military occupation specialty
NATO	North Atlantic Treaty Organization
NBC	nuclear, biological, and chemical
NBCCS	nuclear, biological, chemical contamination survivability
NDAA	National Defense Authorization Act
NIGA	neutron-induced gamma activity
NRT	near real time
NTA	non-traditional agent
OEP	OTA evaluation plan
OTA	operational test agency
PAM	pamphlet
PL	public law
POL	petroleum, oil, and lubricant
psi	pounds per square inch
QA	quality assurance
QC	quality control
QSTAG	Quadripartite Standardization Agreement
R <sup>2</sup>	correlation value
RAR	Rapid Action Revision
RH	relative humidity
SDK	skin decontamination kit
SME	subject matter expert
SOMTE	soldier, operator, maintainer, tester and evaluator
SOP	standing operating procedure
SST	solid sorbent tube
STB	supertropical bleach
SUT	system under test
T&E	test & evaluation
TB	technical bulletin

## APPENDIX E. ABBREVIATIONS

TEMP	test and evaluation master plan
TGD	thickened soman
TIC	toxic industrial chemical
TIM	toxic industrial material
TIR	test incident report
TOP	test operations procedure
USANCA	US Army Nuclear and Combating Weapons of Mass Destruction Agency
USD (AT&L)	Under Secretary of Defense (Acquisition, Technology, and Logistics)
VDLS	VISION Digital Library System
VISION	Versatile Information Systems Integrated Online Nationwide
VX	persistent nerve agent

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The inclusion of SOPs is only to serve as an example of these type procedures that are used at DPG and as a reference for other installations. Many SOPs are specific to a particular installation, facility, or instrument, and may not be applicable between different installations, facilities, or instruments without modifications. It is expected that installations will have their own equivalent SOPs. These equivalent SOPs must be provided to the Test & Evaluation (T&E) community interested in this test method in order to properly understand the data produced, any differences between test method application between installations, and therefore, the ability to compare data produced by different installations. If an installation does not have an equivalent SOP already in place, these or other similar procedures could be used as temporary guides until appropriate SOPs are developed. The most current version of these SOPs can be requested through Developmental Test Command (DTC) or through access to Versatile Information Systems Integrated Online Nationwide (VISION) Digital Library System (VDLS).

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APPENDIX G. CHEMICAL DETECTION POINT AND STANDOFF CAPABILITY  
AREA PROCESS ACTION TEAM (CAPAT) CONCURRENCE.

Test Operations Procedure 8-2-510:CBRCS: Large Item Exterior.

DECONTAMINATION CAPAT CONCURRENCE SHEET	
Bill Davis Collective Protection Commodity Area Process Action Team (CAPAT) Chair	Steve Tackett US Army Test and Evaluation Command (ATEC)/U.S. Army Evaluation Command (AEC)
<i>Bill Davis</i> 10/26/10 Signature Date	<i>Steve Tackett</i> 25 Oct 2010 Signature Date
Bob Burkholder Air Force Operational Test and Evaluation Center (AFOTEC)	Ann Gossage Marine Corps Operational Test & Evaluation Activity (MCOTEA)
Signature Date	Signature Date
LCDR Jeff Einsel Commander Operational Test and Evaluation Force (COMOTEVFOR)	Deb Shuping Test and Evaluation Office (TEO)
Signature Date	<i>Deborah B. Shuping</i> 10/26/10 Signature Date
Juan Vitali Joint Program Executive Office for Chemical Biological Defense (JPEO-CBD)	Michael Roberts Joint Science and Technology Office (JSTO)
Signature Date	Signature Date
Valerie Hasberry, Lt Col, USAF Joint Requirements Office for Chemical, Biological, Radiological, and Nuclear Defense (JRO-CBRND)	
<i>Valerie L. Hasberry</i> 14 May 10 Signature Date	

Figure G-1. Page 1 of CAPAT signature sheet.

APPENDIX G. CHEMICAL DETECTION POINT AND STANDOFF CAPABILITY  
AREA PROCESS ACTION TEAM (CAPAT) CONCURRENCE.

Test Operations Procedure 8-2-510:CBRCS: Large Item Exteriors.	
DECONTAMINATION CAPAT CONCURRENCE SHEET	
<b>Bill Davis</b> Collective Protection Commodity Area Process Action Team (CAPAT) Chair	<b>Steve Tackett</b> US Army Test and Evaluation Command (ATEC)/U.S. Army Evaluation Center (AEC)
Signature _____ Date _____	Signature _____ Date _____
<b>COL James K. Eck</b> Air Force Operational Test and Evaluation Center (AFOTEC)	<b>Ann Gossage</b> Marine Corps Operational Test & Evaluation Activity (MCOTEA)
Signature _____ Date _____	Signature _____ Date _____
<b>LCDR Jeff Einsel</b> Commander Operational Test and Evaluation Force (COMOPTEVFOR)	<b>Deb Shuping</b> Office of the Deputy Under Secretary of the Army Test and Evaluation (DUSA-TE)
Signature _____ Date _____	Signature _____ Date _____
<b>Juan Vitali</b> Joint Program Executive Office for Chemical Biological Defense (JPEO-CBD)	<b>Michael Roberts</b> Joint Science and Technology Office (JSTO)
Signature _____ Date _____	Signature _____ Date _____
<b>Valerie Hasberry, Lt Col, USAF</b> Joint Requirements Office for Chemical, Biological, Radiological, and Nuclear Defense (JRO-CBRND)	<b>William Noel Saunders</b> Joint Project Manager Decontamination (JPM- Decon)
Signature _____ Date _____	 Signature _____ Date <b>19 OCT 2010</b>

Figure G-2. Page 2 of CAPAT signature sheet.

APPENDIX G. CHEMICAL DETECTION POINT AND STANDOFF CAPABILITY  
AREA PROCESS ACTION TEAM (CAPAT) CONCURRENCE.

Test Operations Procedure 8-2-510:CBRUS: Large Item Exteriors.



DECONTAMINATION CAPAT CONCURRENCE SHEET	
<p>Bill Davis Collective Protection Commodity Area Process Action Team (CAPAT) Chair</p>	<p>Steve Tackett US Army Test and Evaluation Command (ATEC)/U.S. Army Evaluation Command (AEC)</p>
<p>Signature _____ Date _____</p>	<p>Signature _____ Date _____</p>
<p>Bob Burkholder Air Force Operational Test and Evaluation Center (AFOTEC)</p>	<p>Ann Gossage Marine Corps Operational Test &amp; Evaluation Activity (MCOTEA)</p>
<p>Signature _____ Date _____</p>	<p>Signature _____ Date _____</p>
<p>LCDR Jeff Einsel Commander Operational Test and Evaluation Force (COMOPTEVFOR)</p>	<p>Deb Shuping Test and Evaluation Office (TEO)</p>
<p> Signature _____ Date 05/06/2010</p>	<p>Signature _____ Date _____</p>
<p>Juan Vitali Joint Program Executive Office for Chemical Biological Defense (JPEO-CBD)</p>	<p>Michael Roberts Joint Science and Technology Office (JSTO)</p>
<p>Signature _____ Date _____</p>	<p> 5/17/2010 Signature _____ Date _____</p>
<p>Valerie Hasberry, Lt Col, USAF Joint Requirements Office for Chemical, Biological, Radiological, and Nuclear Defense (JRO-CBRND)</p>	
<p>Signature _____ Date _____</p>	

Figure G-3. Page 3 of CAPAT signature sheet.

APPENDIX G. CHEMICAL DETECTION POINT AND STANDOFF CAPABILITY  
AREA PROCESS ACTION TEAM (CAPAT) CONCURRENCE.


Test Operations Procedure 8-2-510:CBRCS: Large Item Exteriors.	
DECONTAMINATION CAPAT CONCURRENCE SHEET	
Bill Davis Collective Protection Commodity Area Process Action Team (CAPAT) Chair	Steve Tackett US Army Test and Evaluation Command (ATEC)/U.S. Army Evaluation Command (AEC)
Signature _____ Date: _____	Signature _____ Date: _____
Bob Burkholder Air Force Operational Test and Evaluation Center (AFOTEC)	Ann Gossage Marine Corps Operational Test & Evaluation Activity (MCOTEA)
Signature _____ Date: _____	Signature _____ Date: _____
LCDR Jeff Einsel Commander Operational Test and Evaluation Force (COMOPEVFOR)	Deb Shaping Test and Evaluation Office (TEO)
 Signature _____ Date: 05/06/2010	Signature _____ Date: _____
Juan Vitali Joint Program Executive Office for Chemical Biological Defense (JPEO-CBD)	Michael Roberts Joint Science and Technology Office (JSTO)
Signature _____ Date: _____	Signature _____ Date: _____
Valerie Hasberry, Lt Col, USAF Joint Requirements Office for Chemical, Biological, Radiological, and Nuclear Defense (JRO-CBRND)	
Signature _____ Date: _____	

Figure G-4. Page 4 of CAPAT signature sheet.

APPENDIX G. CHEMICAL DETECTION POINT AND STANDOFF CAPABILITY  
AREA PROCESS ACTION TEAM (CAPAT) CONCURRENCE.


Test Operations Procedure 8-2-510:CB RCS: Large Item Exteriors.	
DECONTAMINATION CAPAT CONCURRENCE SHEET	
Bill Davis Collective Protection Commodity Area Process Action Team (CAPAT) Chair	Steve Tackett US Army Test and Evaluation Command (ATEC)/U.S. Army Evaluation Command (AEC)
Signature _____ Date _____	Signature _____ Date _____
Bob Burkholder Air Force Operational Test and Evaluation Center (AFOTEC)	Ann Gossage Marine Corps Operational Test & Evaluation Activity (MCOTEA)
Signature _____ Date _____	Signature _____ Date _____
LCDR Jeff Einsel Commander Operational Test and Evaluation Force (COMOPTEVFOR)	Deb Shuping Test and Evaluation Office (TEO)
 19 MAY 2010 Signature _____ Date _____	Signature _____ Date _____
Juan Vitalli Joint Program Executive Office for Chemical Biological Defense (JPBO-CBD)	Michael Roberts Joint Science and Technology Office (JSTO)
Signature _____ Date _____	Signature _____ Date _____
Valerie Hasberry, Lt Col, USAF Joint Requirements Office for Chemical, Biological, Radiological, and Nuclear Defense (JRO-CBRND)	
Signature _____ Date _____	

Figure G-5. Page 5 of CAPAT signature sheet.

APPENDIX G. CHEMICAL DETECTION POINT AND STANDOFF CAPABILITY  
AREA PROCESS ACTION TEAM (CAPAT) CONCURRENCE.


Test Operations Procedure 8-2-510:CBRCS: Large Item Exteriors.	
DECONTAMINATION CAPAT CONCURRENCE SHEET	
Bill Davis Collective Protection Commodity Area Process Action Team (CAPAT) Chair	Steve Tackett US Army Test and Evaluation Command (ATEC)/U.S. Army Evaluation Command (AEC)
Signature _____ Date _____	Signature _____ Date _____
Bob Burkholder Air Force Operational Test and Evaluation Center (AFOTEC)	Ann Gossage Marine Corps Operational Test & Evaluation Activity (MCOTEA)
 Signature _____ Date 14/05/10	Signature _____ Date _____
LCDR Jeff Einsel Commander Operational Test and Evaluation Force (COMOPEVFOR)	Deb Shuping Test and Evaluation Office (TEO)
Signature _____ Date _____	Signature _____ Date _____
Juan Vitali Joint Program Executive Office for Chemical Biological Defense (JPBO-CBD)	Michael Roberts Joint Science and Technology Office (JSTO)
Signature _____ Date _____	Signature _____ Date _____
Valerie Hasberry, Lt Col, USAF Joint Requirements Office for Chemical, Biological, Radiological, and Nuclear Defense (JRO-CBRND)	
Signature _____ Date _____	

Figure G-6. Page 6 of CAPAT signature sheet.

APPENDIX G. CHEMICAL DETECTION POINT AND STANDOFF CAPABILITY  
AREA PROCESS ACTION TEAM (CAPAT) CONCURRENCE.

Test Operations Procedure 8-2-510:CBRCS: Large Item Exteriors.	
DECONTAMINATION CAPAT CONCURRENCE SHEET	
<b>Bill Davis</b> Collective Protection Commodity Area Process Action Team (CAPAT) Chair	<b>Steve Tackett</b> US Army Test and Evaluation Command (ATEC)/U.S. Army Evaluation Command (AEC)
Signature _____ Date _____	Signature _____ Date _____
<b>Bob Burtholder</b> Air Force Operational Test and Evaluation Center (AFOTEC)	<b>Willis Shifflett</b> Marine Corps Operational Test & Evaluation Activity (MCOTEA)
Signature _____ Date _____	<i>Willis Shifflett</i> Signature _____ Date <i>10-05-06</i>
<b>LCDR Jeff Einsel</b> Commander Operational Test and Evaluation Force (COMOPTEVFOR)	<b>Deb Shuping</b> Test and Evaluation Office (TEO)
Signature _____ Date _____	Signature _____ Date _____
<b>Jana Vituli</b> Joint Program Executive Office for Chemical Biological Defense (JPEO-CBD)	<b>Michael Roberts</b> Joint Science and Technology Office (JSTO)
Signature _____ Date _____	Signature _____ Date _____
<b>Valerie Hasberry, Lt Col, USAF</b> Joint Requirements Office for Chemical, Biological, Radiological, and Nuclear Defense (JRO-CBRND)	
Signature _____ Date _____	

Figure G-7. Page 7 of CAPAT signature sheet.

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21 March 2011

APPENDIX H. DEPARTMENT OF DEFENSE (DOD) TEST AND EVALUATION  
STANDARD ENDORSEMENT.DEPARTMENT OF THE ARMY  
OFFICE OF THE DEPUTY UNDER SECRETARY OF THE ARMY  
102 ARMY PENTAGON  
WASHINGTON, DC 20310-0102

DUSA-TE

## MEMORANDUM FOR See Distribution

SUBJECT: Endorsement of Test Operations Procedure (TOP) 08-2-510-A, Chemical, Biological, Radiological Contamination Survivability (CBRCS) Large Item Exteriors, as a DoD T&E Standard

1. Reference: Memorandum, CBDDP T&E Executive, 19 July 10, subject: Chemical and Biological Defense Program (CBDDP) Test and Evaluation (T&E) Standards Development Plan
2. In accordance with Reference 1, TOP 08-2-510A has gone through the T&E Capabilities and Methodologies Integrated Process Team (TECMIPT) review process. It has received signed concurrences from the members of the Decontamination Capability Area Process Action Team (CAPAT) and has been approved by the Director, Army Developmental Test Command.
3. This TOP is based on legacy test procedures which have been updated and improved for specificity and test repeatability. In order to support its Life Cycle Management, to include future updates and improvements, I request that as the TOP is used, any user comments and all data be provided to ATEC for TECMIPT review. It is a reference for CP T&E Strategies (TESs) and T&E Master Plans (TEMPs). Any test deviations from this TOP will result in risk of unreliable data, and should be justified in these documents with supporting rationale.
4. With the enclosed recommendation from the TECMIPT Chair, I endorse this TOP as a DoD T&E Standard for CBRCS testing, and encourage its broad use across all test phases. The T&E Standards are for government and associated program use and access. They are stored on Army Knowledge Online, in the TECMIPT share point site. To obtain access to the site, contact the site administrator, [lynn.coles@us.army.mil](mailto:lynn.coles@us.army.mil). My POC for this action is Deborah Shuping, [deborah.b.shuping@us.army.mil](mailto:deborah.b.shuping@us.army.mil).

Encl

DAVID K. GRIMM  
Chemical, Biological, Radiological  
and Nuclear Defense Program  
Test and Evaluation Executive (Acting)DISTRIBUTION:  
DASD(CBD)  
Army G3/5/7

Figure H-1. Page 1 of DoD Test and Evaluation Standard endorsement.

21 March 2011

APPENDIX H. DEPARTMENT OF DEFENSE (DOD) TEST AND EVALUATION  
STANDARD ENDORSEMENT.

DUSA-TE

SUBJECT: Endorsement of Test Operations Procedure (TOP) 08-2-510-A, Chemical,  
Biological, Radiological Contamination Survivability (CBRCS) Large Item Exteriors, as a DoD  
T&E Standard

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Director, NSRDEC

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Director, ARL/SLAD

Technical Director, ECBC

Director, MCOTEA

Director, JPAIO

Commander, NSWC-DD

Figure H-2. Page 2 of DoD Test and Evaluation Standard endorsement.

21 March 2011

APPENDIX H. DEPARTMENT OF DEFENSE (DOD) TEST AND EVALUATION  
STANDARD ENDORSEMENT.

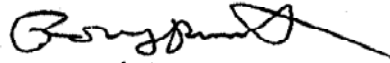
RDAM-CD

23 May 2011

MEMORANDUM FOR Chemical, Biological, Radiological and Nuclear Defense Test and Evaluation Executive, Office of the Deputy Under Secretary of the Army (DUSA-TE/ Deb Shuping), Taylor Building, Suite 8070, 2530 Crystal Drive, Arlington, VA 22202

SUBJECT: Test and Evaluation Capabilities and Methodologies Integrated Process Team (TECMIPT) Recommendation Test and Evaluation Standard Acceptance

1. Reference Test and Evaluation Standard Package – Test Operations Procedure (TOP) 8-2-510 Chemical, Biological, and Radiological Contamination Survivability (CBRCS): Large Item Exterior, dated October 2010.
2. The Decontamination Commodity Area Process Action Team (CAPAT) completed their review of the referenced TOP in accordance with the DUSA-TE Instructions to the TECMIPT, the Standards and Development Plan, and the TECMIPT Standard Operating Procedure (SOP). All signatory members of the CAPAT concur with this TOP.
3. Based upon the concurrence of the CAPAT, I recommend acceptance of this TOP as a Test and Evaluation Standard.



on behalf of  
CARL M. EISSNER  
TECMIPT Chair

Figure H-2. Page 2 of DoD Test and Evaluation Standard endorsement.

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Forward comments, recommended changes, or any pertinent data which may be of use in improving this publication to the following address: Test Business Management Division (TEDT-TMB), US Army Developmental Test Command, 314 Longs Corner Road Aberdeen Proving Ground, MD 21005-5055. Technical information may be obtained from the preparing activity: Commander, US Army Dugway Proving Ground (TEDT-DPW-TT), Dugway, Utah 84022-5000. Additional copies can be requested through the following website: <http://itops.dtc.army.mil/RequestForDocuments.aspx>, or through the Defense Technical Information Center, 8725 John J. Kingman Rd., STE 0944, Fort Belvoir, VA 22060-6218. This document is identified by the accession number (AD No.) printed on the first page.